SEVENTEENTH ANNUAL REPORT

OF THE

Quebec Society for the Protection of Plants

1924-1925

Supplement to the report of the Minister of Agriculture

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QUEBEC
1925

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To the Honourable J. E. Caron, M.P.P.

Minister of Agriculture,

Quebec.

Sir :—

I have the honour to present herewith the seventeenth Annual Report of the Quebec Society for the Protection of Plants, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on Wednesday, April 15th, 1925.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

E. Melville DuPorte,

Secretary-Treasurer.

Macdonald College, Quebec.

QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS.

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Winn, A. F.	32 Springfield Ave., Westmount.
Yauch, C. M.	Agric. School, Olds, Alberta.

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J. C. Chapais, D.Sc., St-Denis-en-bas, Que.
A. Gibson, Esq., Dominion Entomologist, Ottawa.
Hon. Minister of Crown Lands and Forests, Quebec.

FINANCIAL STATEMENT OF THE QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS 1924-1925.

RECEIPTS

Balance forward	$174.49	
Government Grant	250.00	
Interest	6.21	
		$430.70

EXPENDITURE

Delegate to Royal Society	$ 39.05	
Secretary's stipend	50.00	
Delegate to British Association	47.00	
Clerical work	10.00	
Delegates to Phytopath Society	33.80	
Delegate to Ont. Ent. Society	28.50	
Postage	2.75	
Lecturer at Annual Meeting	40.00	
Incidental expenses of Annual Meeting	1.21	
Balance on hand April 30th, 1925	$178.39	
		$430.70

Audited and found correct.

T. G. COULSON.

W. LOCHHEAD,
President.

E. MELVILLE DUPORTE,,
Sec. Treasurer.

MINUTES OF THE SEVENTEENTH ANNUAL MEETING.

The Seventeenth Annual Meeting of the Quebec Society for the Protection of Plants was held in the Biology Building, Macdonald College on Wednesday, April 15th, 1925.

The two general sessions were well attended. At the afternoon session Principal F. C. Harrison welcomed the guests and members, congratulating the Society on the good work it is doing and on the progress it has made. The papers read during this session are included in the report.

In the evening Dr. B. T. Dickson gave a short account of the history of the Society. This was followed by the principal address, delivered by Dr. Jas. G. Needham of Cornell University . Dr. Needham's address on "Some New Ventures in Entomology" was keenly enjoyed by the audience, owing in part to the speaker's inimitable manner, and in part to the almost untouched fields of economic Entomology of which we were given a glimpse. This address is printed in the report in a somewhat condensed form.

The business meeting was called to order at 11 a.m. Owing to the absence of the President on acount of illness, the Vice-President, Rev. Father Leopold took the chair.

The minutes of the last meeting were read and approved.

The report of the Secretary-Treasurer was read and accepted.

The following officers were then elected for the year 1925-26.

President:—Prof. W. Lochhead, Macdonald College
Vice-President:—Rev. Father Leopold, La Trappe.
Secretary-Treasurer:—Dr. E. Melville DuPorte, Macdonald College.
Directors:—Prof. E. Campagna, Ste Anne de la Pocatiere.
Dr. A. T. Charron, St. Hyacinthe, Que.
Dr. B. T. Dickson, Macdonald College.
Prof. Father Louis Marie, La Trappe.
Prof. Georges Maheux, Provincial Entomologist, Quebec.
C. E. Petch, Esq., Hemmingford, Que.
Prof. Bro. Victorin, University of Montreal.
A. F. Winn Esq., Montreal.
Auditor:—J. G. Coulson Esq., Macdonald College.
Delegate to the Royal Society of Canada:—Dr. Dickson.
Delegates to the Canadian Branch of the American Phytopathological Society:—Dr. Dickson, Rev. Father Leopold, Mr. O. Caron, and Mr. J. G. Coulson.

A Committee was appointed to assist the Ontario Entomological Society in making local arrangements for their Annual Meeting to be held in Montreal, in November. The members of this Committee are Prof. Lochhead, Mr. Petch, Mr. Winn, Father Leopold, Prof. Maheux and Dr. DuPorte.

On the motion of Mr. Arthur Gibson and Dr. B. T. Dickson the Secretary was directed to send a telegram to Prof. Lochhead regretting his illness and hoping for his speedy recovery.

The Society delegated Prof. Maheux to interview the Minister and decide on some definite policy regarding the supplying of separates to contributors.

It was resolved that as far as funds are available the Society should continue to make grants not exceeding fifty dollars in aid of investigations on plant diseases caused by insects fungi or bacteria it being understood that the report on such investigations shall be presented to the Society at its Annual Meeting.

SOME NEW VENTURES IN ECONOMIC ENTOMOLOGY

By James G. Needham,

Prof. of Entomology and Limnology, Cornell University.

In the economy of nature insects play a large part. I invite your attention to their role as agents for the turnover of plant food materials. It is a double role. In the first place they eat plant stuffs both living and dead more in the aggregate than does any other class of animals and by the disintegration of these stuffs they restore the organic materials of the world's food supply to circulation. Thus they aid in the maintenance of a richer and more abundant life upon the earth. In the second place they themselves become food for the carnivores. Of the world's supply of flesh for land animals they are the major part. Practically all land carnivores eat insects and some of them eat mainly insects. Though insects are no part of our diet they have much to do with the maintenance of our diet; and it is of the part they play as agents of food turnover that I wish to speak. They directly feed some of the best of our game birds and food fishes and are often the limiting factor in the production of these choice human foods.

Perhaps we may derive some useful ideas concerning animal forage by recalling how the betterments in our own diet were made.

Mankind at the first lived as do the wild beats on what nature furnished ready made. *All men were sheer exploiters.* Then they learned the use of fire for cooking and of *simple tools for cutting* and for crushing food products; thereby they greatly increased the range and variety and value of their diet; but they were still exploiters. Then they selected a few of the most useful plants and animals *and by care* and culture of them vastly increased their product. This is *the essence of agriculture.* This laid the basis for our civilization by providing a larger and more dependable food supply. This made possible

a larger *population with settled homes* and with increase of leisure and of opportunity for taking thought.

A little more thinking is always in order. It is the prerogative of our species. We get on by thinking upon the ways of nature, and by imitating them under altered conditions that yield better results. Since the human population has almost overtaken the food supply and is ever on the increase, if we would not rob the earth of every remaining element of primeval beauty or potential benefit, it behooves us to be taking thought of better ways for utilizing the part of it that we have already despoiled. We have fields enough for the present, and far too many wastes. In our utilization of plant products there are great losses. Usually, about one part is saved and three parts thrown away. And about in proportion to the richness of its organic content, the part thrown away becomes a burden of offense. Nature has many agents for the reclamation of these rich wastes, and we may learn to use them to our profit by taking thought.

The earliest of our betterments consisted in the mechanical treatment of natural products. The devices were very simple; a flat stone for cracking nuts; a hollow stone for pounding acorns; a mortar and pestle for grinding grains. The last was a simple mill, and complicated mills followed afterwards and made bread for our species "the staff of life'. Though we have long been dependent on mills for the preparation of the cereal staples of our diet, we have little considered what mechanical treatment might do by way of preparation of food for some of the lesser organisms.

It is insects I have in mind: herbivorous insects that are themselves the food of some of our most desirable birds and fishes. I have been directing some experiments in the mechanical preparation of foods for them in the hope of obtaining a more abundant supply of them for feeding purposes; and of the results of these experiments I have come before you to make preliminary report.

The larvae of certain midges and flies have been the subjects. The midge first use was *Chironomus decorus*. Larvae of this species hatched from the egg in our aquaria were reared to full maturity on a diet of a single species of pond weed, *Potamogeton crispus*. This plant is not normally eaten by the larvae, but when its substance was made available by grinding it proved a very satisfactory ration. This work was done by Miss Ruth Tillbury and the details of it were published by her in the Journal of the New York Entomological Society.

[The speaker here digressed to mention and to illustrate with lantern slides the work done by P. W. Claassen and Miss Hazel E. Branch on utilizing the larvæ of another midge, *Chironomus cristatus* for clearing out milk wastes in streams. Details of this work have been published in Bulletin of the New York State Agricultural Experiment Station.]

A more extended series of experiments was concerned with providing suitable food for the larvæ of the fily, *Muscina stabulans*. I was drawn into this study by discovering the need of our game bird breeders for suitable insect

food for young pheasants. There is a time in the life of young pheasants before their stomachs are able to digest grain during which they seem to require insect food. Meal worms have been found excellent but they are too expensive to buy and too slow to raise. Blowfly maggots have been found suitable food but the rearing of them in carrion is a thouroughly obnoxious task, which no one likes to perform. The question arose in my mind. Why not use the larvæ of some vegetable-feeding fly and avoid the stenches? It was Miss Laura Florence, who in some initial experiments determined for me that the pulp-feeding larvae of *Muzcina* seem most suitable, and it is these larvæ that I have since been raising. Mishaps and failures by the way, need not be recorded here. Suffice it to say, that a very simple plan has been evolved, the essence of which is the mechanical treatment of more or less succulent green herbs to make their protoplasmic contents available. This is merely the application of the ancient processes of cutting and grinding to disrupting the protective layers of cellulose and lignin, thus exposing the stuffs on which the larvæ may then feed. A great variety of weeds have been used successfully; burdock, sweet clover, dandelion, plantain, etc. These are prepared for use by being run though a green food cutter, such as poultry-men use, and then thourgh a sausage mill and thus reduced to a soft pulp. This pulp intermixed with a little yeast from an old culture is spread out in pans, sprayed with a little cider vinegar to check the growth of mould and to prevent that of yeasts, a little brown sugar is added for bait, two days are allowed for fermentation, and then the pans are exposed in a cage with the adult flies. These, if sexually mature, lay their eggs either on the pulp, or if it be very moist on the sides of the pan just above its surface. Within ten days the larvæ are full grown. The pans are dumped out on the ground in the yard and the young pheasants do the rest.

Here is a phenomenally quick turnover of green plant stuff into flesh. On such food carnivorous birds and fishes thrive, and I see no reason why it may not be provided easily and cheaply in any desired quantity; but the production of it is still a new venture, as my title implies, with many details of the methods still to be worked out.

Since so many unused and often noxious plants have been found suitable sources of food for these larvae, and since they may be equally good food for other birds, such as young turkeys and for fishes, I anticipate that the results of these experiments may find a wide application. May we not have tapped a new source of food supply for human kind by this unexpected route and another aid to the maintenance of our ever increasing population?

[The Speaker then called attention to the simplicity of structure of the *Muscina* larva and to the shifting of metamorphosis that make possible its rapid growth, and then spoke further concerning insect larvae in general as follows:]

The insect larva is an unparalleled biological phenomenon. Oken called it an embryo at large. And so it is; but it is far more than this. For instead of

living its life at the expense of its forebears, after hatching from the egg, it, in its own brief time, accumulates for itself all the materials for the growth of a lifetime. It is a model of fitness and efficiency. It is of about the optimum size for taking advantage of scattered food supplies, as the world offers them—big enough for efficient operation—not so big but that a livelihood may be found in numberless places. It is a simplified arthropod, with all redundant and unnecessary parts removed. No cumbrous parts of the adult insect appear: nothing appears but what is necessary for getting a living and keeping alive; feeding organs and means of keeping to cover; that is all; an irreducible minimum!

The larva represents a segregated period in the life history of the insect—a period of food accumulation and growth. The complicated organs of the adult insect, wings, antennæ, etc., are not seen in the larva. They are present as small rudiments, biding their time, waiting for a more favorable season for further development, waiting on the more important and more pressing business of food-getting. The larva is preeminently fitted for "making hay while the sun shines". More than any other animal of comparable size it lives on perishable and transient foods, and it lives among a host of greedy competitors. It must work fast, and lay up stores. It uses a little food to build such organs as are immediately necessary; the remainder it stores as fat. When it is fully fed it is largely a mass of fat, with a few old and more or less effete nutritive and motor organs disposed through and around the body, and with only the rudiments of adult organs.

Then comes transformation. The larva goes into retirement, and ceases activity. The pupal stage is entered upon. Another marvel ensues. The animal though grown to its maximum size, now returns to a condition comparable to that of an embryo. The rudiments of the adult organs begin to grow. They feed upon the store-up fat, much as in the egg the initial larval organs fed on the yolk therein. Though these rudiments are scattered about the body, they are bound together with the thread of life; they grow and shape themselves and and organize into the perfect insect, with all its organs, all its powers, and all its endowment of inerited behavior.

Clearly the larva would be a helpless, hapless, hopeless thing without the instinctive aid of the mother insect to place it in reach of its proper food.

Such is metamorphosis at its best, truly a world phenomenon, and so manifest only in a portion of the group of insects, a life cycle broken into two periods, corresponding to the two great undertakings of life, growth and reproduction, and separated by a stage for the making over of the one into the other.

Of all biological expedients metamorphosis is clearly one of the most successful if success is measured by dominance. The group of insects outnumbers in species all other kinds of animals put together, and four orders of insects in which metamorphosis is completest are so preponderant that all the others taken together seem but a handful in comparison. These four are the Lepidop-

tera, the Coleoptera, the Diptera and the Hymenoptera; and within these orders those families in which metamorphosis is completest are the large and dominant families.

The one persistent trend through orders and families alike has been toward one type of larva: simple and worm-like, legless and lacking all other appendages, with even the head reduced but with the abdomen enlarged and full of fat, capable at last of only a sheltered existence, and requiring, for the final making over, a pupal period of complete quiescence.

This phenomenon interests us all as biologists; but it is to the food-producing capacity of these larvæ that I am particularly inviting your attention at this hour. Among insect larvæ are to be found the best agents for quick turnover of common plant stuffs and of organic wastes into fresh food for carnivorous animals.

The young of many of our most desirable food species of both birds and fishes seem to require for their best development a diet of insects. On such a diet they have been evolved. To it they are fitted. On it they thrive. Our success in rearing them has been demonstrated to depend on furnishing them with such a diet; but hitherto this has been done in a desultory way and with great uncertainty as to continuity of supply.

The requirements are three—the same as for raising any other animals whatsoever:

1. Suitable food in adequate supply.
2. Suitable shelter including defence against enemies.
3. Maintenance of conditions suitable for growth and reproduction.

The only impediment is ignorance, and lack of scientific method. The cure for this is research; patient, sustained research, and reflection on the ways of nature, and on how we may better adapt them to our own needs. By this means we have made all the betterments of our civilization; and in my judgment the thoroughgoing economic exploration of the world we live in has only just begun.

APPLIED ENTOMOLOGY IN RUSSIA

By Prof. W. Lochhead, Macdonald College.

While in London from January to April, 1924, the writer was fortunate in meeting Prof. B. P. Uvarov of the British Museum of Natural History, who is one of the most prominent of the younger Russian entomologists. He was good enough to give the writer much valuable information regarding entomology in Russia, and through his kindness several abstracts and translations of papers and addresses of an historical nature were secured which the writer has used quite freely.—).

The study of insects in Russia has been carried on mainly by four sets of agencies: the **Entomological Societies,** the **Museums,** the **Bureau of Applied Entomology, and Local Stations and Bureaus.**

1. The Societies:

The Russian Entomological Society, Petrograd, founded in 1850, is the oldest of the Societies. A short history of the period 1860-1910 was published in: "Horae Societatis Entom. Russicae", XXXIX, 1910; Annual reports for 1911 to 1915 are published in the "Revue Russe d'Entomologie" while the report for the years 1916-1920 is to be found in the "Bulletin of the Second Entomo-phytopathological Conference in Petrograd"

The Entomological Society of Moscow was founded in 1914, and three volumes of the Reports have been published in the: "Bull, de la Soc. Ent. de Moscow".

The Russian Association of Economic Entomologists was founded in 1913 at Kiev during the First All-Russian Entomological Conference. Two volumes of the "Russian Journal of Applied Entomology" have been published. During the war its work was largely suspended, but its activity was revived in 1922, at Moscow.

2. Museums:

The Zoological Museum of the Russian Academy of Sciences, Petrograd is a very old (nearly 100 years) institution, with a large entomological department, where enormous collections especially of Palaearctic insects are accumulated. Reports on the work may be found in the yearly volumes of the "Annuaire de Musée Zoologique de l'Academie des Sciences."

The Zoological Museum of the Moscow University. This museum is not so important from an entomological point of view as the Petrograd Museum, but a certain amount of systematic work is carried on there

The Museum Caucasicum now called Musée de Georgie, in Tiflis, Transcaucasia, possesses very rich collections of the entomological fauna of Caucasus. Persia and Armenia, and has published a series of annual reports.

Small provincial museums, with entomological departments, are in Kiev, Ekaterinburg, Minussinsk, Tomsk, Tashkent, Stavropol, Simferopol, Kherson.

3. The Bureau of Applied Entomology of the State Institute for Experimental Agriculture, Petrograd, was founded in 1894. A short history of this Bureau was outlined in a paper by Bogdanov-Katkov (1923); while the present organization and plans for the future are given in another paper by Prof. Pospelov, present Chief of the Bureau.

4. Local Stations and Bureaus.

These are about fifty in number. A history and brief summary of organi, zation and work up to 1915 is given by I. I. Mamontov.

When one is informed that the complete list of Russian literature on Economic Entomology occupies over 200 pages of small type, in two columns, in a forthcoming publication of the **Review of Applied Entomology,** one begins to wonder if he is not playing the part of a new Rip van Winkle who has slept while the world has progressed. Russia has been to a large extent cut off so

long by the barrier of language from the rest of the world that the great work she has done is known only to a few of her nearest neighbours and to occasional visitors from the West.

Some of the first references to Russian insects in American literature are found in the First and Second Reports of the U. S. Entomological Commission relating to the Rocky Mountain Locust (I. pp. 467-475; II, pp. 35-41), where excellent accounts are given of the devastations caused by locusts in Russia; also good descriptions of the habits and life-history of the Russian Migratory Locust (taken mainly from Köppen's Memoirs).

The work of Russian Entomologists was again brought to the attention of American students through the introduction of the Gipsy Moth into New England. It was there found that this insect had been a serious pest to forests and orchards for many years in southern Russia. In the well-known work of Forbush and Fernald on "The Gypsy Moth" (1896) a good record is given of the references to the economic works of Keppen, Rudsky, Porchinsky and Hulagin of the distribution and depredations of the Gypsy Moth.

Later the Bureau of Entomology of the U. S. Department of Agriculture sent experts to Russia in an effort to obtain parasites of the Gypsy and Brown Tail Moths. In 1907 Dr. L. O. Howard visited Kiev, Odessa, Kishenev and the Crimea, and got into touch with the eminent entomologists, Porchinsky, Pospielov, Krassilstschik and Moktzhecky. In 1909 Prof. Trevor Kincaid went to Russia and studied the situation at Kiskenev and Kiev; and Mr. W. F. Fiske spent a few weeks in Kiev and Kharkov provinces in 1910. (Bull. 91, Bureau of Entomology)..

THE DEVELOPMENT OF ENTOMOLOGY

(Based on a Paper by Bogdanov Katkov given in 1923.)

Up to the middle of the last century entomology in Russia was studied only by a few individuals, and many of those were foreigners. Among these may be noted K. Laxmann, P. C. Pallas T. G. Girelin, T. Zzderhelm, T. A. Dvigoubsky, D. Goummel, G. T. Fisher, F. Faldermann, R. G. Mannerheim, E. A. Eversman, H. H. Steben, B. G. Besser, V. T. Motchoulsky, V. P. Zoubkoff, A. D. Nordman, and T. F. Escholtz. About 1850 however an organization called the Russian Entomological Society, was formed but it was not until 1859 that the constitution of the Society was decided. From the beginning of its existence this society has given considerable attention to economic and applied entomology, and during its first year a special committee of six persons was appointed to deal with insect pests. In 1862 the committee with 1500 roubles at its disposal, invited A. A. Koushakevitch to investigate locusts, T. U. Simasjko forest insects, chiefly bark beetles in the province of Petersburg, and O. B. Bremer cutworms in the province of Kostroma. In 1867 F. P. Kepper studied the locusts in the Crimea, and L. F. Rougsky the hessian fly and the gypsy moth. After 1868 the special committee ceased to function, its work being taken over by the secretaries of the Society who frequently sent its members to investigate the outbreaks.

About 1876 owing to a series of severe insect outbreaks that occurred throughout the whole of southern Russia, the local authorities were forced to demand help from the universities and the Department of Agriculture, and to request the formation of entomological centres in Kharhov and Odessa. As a result, the first "Entomological Commissions" were established, that at Kharhov in 1878 and that at Odessa in 1882. To the former belonged the noted scientists Metchnikoff Zenhovsky, Yaroshevsky and Stepanoff. The work in Odessa was under the direction of Yakounin. As the members were mostly university professors and instructors they could devote but a part of their time to the work. Much valuable work was done, however, and several conferences of entomologists from eleven of the southern provinces were held. At the 7th conference at Odessa the post of "regional entomologist" for the whole of south Russia was established and given to P. A Sabarinsky.

In 1892. when a very serious outbreak of *Eurygaster maurus* destroyed about 60,000 acres of wheat in the Crimea, the local government decided to establish the post of "provincial

entomologist" with A. Mokrzhecky as first occupant. In spite of great handicaps of lack of equipment, scientific help , money and mistrust on the part of the people, Mokrzhecky worked courageously alone for fifteen years, and made many contributions to entomological literature. He made observations on about 500 species of insects, and published over 350 papers in less than 20 years.

Following the example of the Crimea, many other local governments (Zemstvos) soon opened their own entomological stations.

As a further development of the idea of a more intensive study of insect pests by the limitation of the working area, the Board of Directors of the South Russian Agricultural Society in Kiev in 1903 requested the Department of Agriculture to establish a post of en omologist, the Society effering to pay all the expenses in connection with the equipment of the laboratory and the local work of the entomologist. In the following year (1904), the Department approved of the formation of an "entomological station" in the South Russian Agricultural Society. Similar entomological stations or bureaus were soon opened in other places. In 1916 twenty one such station were operating, and now (1923) there are over fifty.

If, in addition, the permanent entomological organizations that are connected with the local natural history museum in Kherson (since 1897), in the Crime (since 1899.) and other places are taken into consideration, it will be seen that most of the provinces of Russia concerned with grain growing are supplied with organizations for dealing with insect pests.

The need for a central bureau of entomology had been felt for many years, by the Russian Entomological Society and in 1894 the Bureau of Applied Entomology of the State Institute for Experimental Agriculture was founded in Petrograd under the leadership of T. A. Porchinsky. It has been very successful, and the investigations of Schreiner, Vasiliev, Rossikov, Dobrodere and Porchinsky relate to the most important pests of Russia. The publications of the Bureau are the best on the subject in the Russian language. However, the success of the Bureau has been the means of centralizing the work in Applied Entomology instead of founding and supporting local entomological institutions in different parts of Russia.

The development of entomology in Russia has been very rapid since 1895. As has been said the first provincial entomologists had neither microscopes nor equipment, and worked under many adverse conditions, but in 1905 more than ten well organized institutions with experienced entomologists and assistants existed, and in 1910 there were over 100 persons giving their attention to applied entomology.

When the Russian Entomological Society was founded (1850), there were only 102 entomologists in Russia, more than half of them being amateurs, while only three or four persons worked in applied entomology. In 1910 the number of entomologists were 340, and in 1923 there were 288, a reduction due to the Great War and Revolution.

Before 1890 entomology was not taught anywhere as a separate subject, but as a part of the general course of zoology. Since, however, more attention has been given to the science by the universities at Warsaw, Moscow, Kharkov, Petrograd, Kazan and Kiev. In addition, economic workers have been trained at the Petrograd Institute of Forestry where a school was organized by Cholodkovsky, at the Agricultural course of Petrograd under Silanter. at the Moscow Agricultural Academy where a school was organized by Koulagin and Boldigraff, at the Novo-Alexandra Agricultural Institute were students worked under Tarnani, and at the Polytechnic of Kiev. Moreover, many of the entomologists were trained at the entomological stations, at Kiev under Pospeloff; at Kharkoff under Averin; at Plotava under Rourdumov; at Stavropol under Uvarov; and in the Crimea under Mokrzhechky. Often the training was completed in the Zoological Museum of the Russian Academy of Sciences, in the Russian Entomological Society, and at the Northern Station for Protection of Plants at Petrograd.

LOCAL INSTITUTIONS FOR CONTROL OF PESTS OF AGRICULTURE

Entomological and Phytopathological Stations and Bureaus.

ENTOMOLOGICAL STATIONS IN RUSSIA

(Based on a paper by I. I. Mamontov in 1915, head of the Entomological section of the Minister of Agriculture and initiator of nearly all the Entomological organizations.)

General Description:—

Entomological stations are very recent institutions both in Russia and in other countries The necessity of organizing a systematic study of insect pests with the object of finding only the best means for destroying them was first felt in the United States where in 1854, the post of entomologist was established by the Agricultural Society of New York State. In Russia the question of instituting an establishement of this kind was first discussed in 1883 at the first entomological

Conference in Odessa, which was called mainly for discussing measures of destroying *A nisoplia* a genus of chafers. As a result of the decision of the Seventh Entomological Conference in Odessa there was established at theEntomological Commission of Odessa a post of economic entomologist supported by the joint funds of all the zemstvos (1) that took part in the work of this Commission. Thus was started the local entomological organization.

The question of a systematic study of pests of agriculture, which was first discussed at the First Entomological Conference at Odessa, was only taken up twenty years later. In 1903 the Board of Directors of the "South Russian Society for Encouraging Agriculture and Rural Industry in Kiev presented to the ministry of agriculture a memorandum pointing out the great amount of damage caused to agriculture, in particular to the beetroot plantations in the South-western region and the provinces next to it, by different insect pests and asked that a post of entomologist to the Society be established at the joint expense of the Society and the Department of Agriculture, and promising to finance all the expenses incurred in equipping the entomological laboratory for the work of the entomologist. This request was at first declined owing to the fact that the need of entomological help in the south-western region was already, to a certain extent met by the yearly despatching there of the entomologists of the Department; but next year the Department of Agriculture saw its way to change its decision, and on February 24th it issued a regulation to establish an entomological station in the South Russian Agricultural Society.

Following the example of the entomological station in Kiev, other parts of Russia soon opened stations and bureaus of this kind and by 1916 there were already 16 such institutions. The aim of these institutions was threefold:—

1. The study of pests in their particular region, and determining the best means, according to local conditions, for destroying them.
2. The dissemination of knowledge regarding the best means of destroying such pests among the peasants and owners of land.
3. The direction of measures for destroying such pests, should they appear *en masse*.

Of these three problems, the most important for all the entomological stations and bureaus was the last one; that of directing measures for the control of insect epidemics. This was the more important because most of these stations and bureaus were founded when it became absolutely necessary to take immediate measures for destroying the insects. This direction was of such a character that the staff of the establishments not only organized but also took part in the execution of the control measures.

This field of activity took up most of the time of the staff and hindered the development of other lines of work, so these institutions naturally made it their aim to persuade the peasants to handle the different measures for destroying the pests *en masse* under the guidance and instruction of specialists from the station or bureau, or the properly instructed agronomist, or some other suitable member of the staff.

The dissemination of knowledge about pests with rational means for destroying them among the peasants was found to be a difficult problem. It was all the more difficult because the institutions had to reply to the questions of peasants and of owners of land concerning not only the destruction of insect and animal pests, but also the control of plant diseases.

Under such conditions, in the course of time there naturally arose the advisability of separating the phytopathological questions form the purely entomological institutions. The first entomological institution to do this was that of Kiev, which was reorganized in 1913 into a station for the protection of plants from pests.

The idea of dividing an institution into separate sections according to the established classification of the harmful organisms, was most fully expressed in regulations issued in 1916.

The regulations (2) divide the staffs of these bureaus into specialists in the three following subjects:—

1. Applied entomology;
2. Applied zoology; and
3. Phytopathology.

thus dividing these institutions into three separate sections.

Moreover, these institutions are obliged to consider the fact that, apart from more or less known insects and fungous pests, there exist other pests from which the cultivated plants occasionally suffer, but which have not attracted the attention of the peasants owing to the insignificant harm done by them.

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(1) Local provincial government.

(2) Worked out by B. P. Uvarov, who was entrusted with organization of plant protection in the Caucasus in 1915.

On this account and through the necessity of having collections of insect pests of their district for purely practical purposes, such as demonstrations during lectures, exhibitions, etc., and also the need of lending such collections to schools, cabinets of the local agronomists, (1) etc. the institutions were obliged to collect all pests regardless of the amount of harm done by them. The collected material is then sorted, and studied with the help of institutions such as the Zoological Museum of the Academy of Sciences, the Central Phytopathological Station, etc. Accordingly there gradually developed a close connection between the entomological institutions and the Central Scientific institutions.

The collections become all the more valuable if they present the whole life history of pests, for it is possible to fight against them in one or other of their stages with the greatest success, only when the conditions in which they live during different stages of their development are fully known.

Special attention is therefore paid by these institutions to observations on the pests in their natural surroundings, on plots of land specially set apart for such experiments, in gardens, etc., or other observation points, with the further confirmation of these observations in laboratories, where cages are used in the different stages in their development, In this manner the problems of these institutions came to a certain degree in contact with problems attacked by institutions of a purely experimental type.

The experimental institutions have this advantage over the others in that they can confirm their observations, taking into consideration the factors which have their effect upon the cultivated plants and consequently on the organisms which live on these plants. Therefore those institutions whose principal purpose was to help peasants to destroy pests, being deprived of the necessary means (such as specially prepared plots of land), usually did not attempt to find means of thus destroying these insects which are not yet fully known.

Thus a dividing line crept in between the entomological or phytopathological bureaus and the entomological or phytopathological stations. This line, owing to the weakness in the development of the respective sections of experimental stations, is not yet clearly defined, and the research functions, especially in cases of absence of an experimental institution in the particular region, are so far as possible performed by the bureau. This part of their work cannot claim to be thorough and complete as will be clearly seen in the description of the entomological stations and bureaus given later on. At the same time in some cases, especially where there has been formed a close connection between the entomological bureau and experimental institution, the applied scientific investigations have been fairly well developed.

To the investigational work must be added the testing of different substances and apparatus for destroying the pests, which was done by many entomological stations and bureaus. In some cases the results of these experiments proved to be very important in organizing control measures (for example, the testing poison baits to destroy locust proved the possibility of adopting this method, which is much cheaper and simpler than spraying the plants with poison.)

If the measures for destroying insect pests *en masse* have more or less reached their aim, the same cannot be said about demonstrating to peasants the means for destroying pests, for in many cases this part of their work has not been fully and widely developed.

The reason for this lies in the fact that owing to the smallness of their staffs, the institutions were not in a position to do the work, while the local agronomical staffs, whose work it really should have been, usually proved themselves insufficiently prepared for it. Therefore, many stations and bureaus tried to organize a special staff of instructors in insect control from among the local agronomical staffs, by giving special courses of instruction.

Besides this, some of the isolated entomological institutions with their own forces made demonstrations of control measures to the peasants, by means of "flying detachments".

As the success of demonstration work depends upon the facility with which peasants can obtain the necessary apparatus for using different kinds of substances for destroying pests, special attention was paid by the entomological stations and bureaus to enable the peasants to obtain such apparatus more easily by establishing store houses in the institutions; in addition measures were taken that the storehouses should sell only those apparatus and substances which had already been tested by the entomological institutions.

As to the other work of the station entomologists, the most highly developed part of it was the consultation work.

Entomological stations and bureaus, being first of all the advisers of the respective local institutions, are often requested by them to discuss at conferences, meetings, etc, different methods of destroying agricultural pests. At the same time they are obliged to give advice to those who ask for information, advice or directions. These purposes are accomplished by the staffs in two ways:—

(1) Local instructors in agriculture.

1. By organizing all kinds of lectures, discussions and demonstrations on the subject of destroying agricultural pests, either at the stations or bureaus, or at the place where help is wanted;
2. By correspondence and personal intercourse with (a) regular correspondents of the station who periodically supply the entomological institutions with information about pests, and (b) with occasional correspondents who write, enquiring regarding the particular agricultural pests which interests him the most at that moment.

As to lectures and discussion on the subject of agricultural pests, these are varied both as regards subject and length. Apart from lectures on subjects suggested by the needs of the moment, such as the appearance of some particular pest, or the necessity for doing some seasonable work for destroying pests), which lasted a comparatively short time (one or several hours), the entomologists and mycologists organized lectures and discussions on broader subjects which lasted several days, and which somewhat resembled the regular courses.

Regarding the consultative correspondence with individuals, some of the stations and bureaus made it their special aim to develop this part of their activity. This proved to be possible in those cases where the station or bureau succeeded in securing a number of permanent correspondents and led to the framing of special forms of answers to certain enquiries.

Closely connected with such consultative work was the popularizing of entomology, which, was done by the publication of many kinds of popular leaflets and pamphlets and the contributions of popular articles by specialists to local periodical agricultural journals. Many stations and bureaus issued tens of thousands of such publications which were distributed as widely as possible in the region.

Lastly it must be stated that entomological stations and bureaus sent their representatives to other regions for the discussion of questions relating to the destruction of agricultural pests. These conferences served as a helpful bond of connection among all the institutions.

The question of forming such permanent connection, by instituting a special permanent central bureau, was discussed at the meeting of the Russian Association of Economic Entomologists in October, at Kiev 1916, which consists of representatives of all the economic entomological establishments.

ENTOMOLOGICAL STATIONS IN RUSSIA

1. North Western Region:—

The Baltic station for the protection of cultivated plants from pests (1) is the only one in this region.

This Station has existed in Riga since 1914, and includes a special 'Division of Forest Entomology" under the direction of a specialist-entomologist. Here the pests of forest and decorative trees, and to some extent fruit trees and shrubs are studied exclusively. Special attention is paid to those insects which cause the most frequent and greatest damage to trees on the Baltic coast.

2. Warsaw Province: (2)

In this Province is the Experimental entomological station in Borovock near Warsaw, of the Society of Lovers of Nature in Warsaw.

This station was founded in March ,1913, by the Society of the Lovers of Nature, and its activities commenced in the beginning of June of the same year. One of its foremost problems is the study of the biology of garden pests of the region, with the object of organizing measures for coping with them. Besides this, the station made observations on species of Elateridæ and on *Aphis papaveris* which injure the beetroots. In the end of September, 1914, the two-storey stone building of the station suffered from war activities, and the greater part of the property was destroyed. (3)

3. The Central Region:—

This region consists of the provinces of Kaluga, Tula, Kjazan, Voronezh, Orel, Kursk, Kharkov and Poltava. There is a permanent entomological organization in each of these provinces, the oldest of which is that of Tula.

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(1) At present not in Russia, as Baltic provinces are independent.
(2) At present in Poland.
(3) At present the entomological organization in Poland is being re-organized under the direction of Prof. S. A. Mokrzehcky, a well-known Russian entomologist, and a Pole by birth.

Tula Entomological Station:—

Since 1897 a great deal of harm has been repeatedly done to the agriculture of Tula by the appearance of different insects, mostly Hessian fly and cut-worms. These losses at last attracted the attention of the Zemstvo of Tula, and at the conference of the local authorities held in Tula in 1909 it was decided to ask the government for 25,000 roubles (1) for the purpose of controlling the insects, and also to request the Ministry of Agriculture to establish an entomological station there.

Permission to establish an entomological station was given by the Ministry on March 9th, 1910.

With the object of studying the harmful insects of this province the station made a special effort to make its observation as far as possible in natural surroundings, and at the same time in different parts of the province. To this end the station secured a number of temporary experimental plots of land in those parts of the province where the pest to be studied was found in largest numbers. The experimental plots organized in this manner enabled it to find out the connection that existed between the life of the pests, their number, the amount of harm done by them, and the economic and other conditions of the given region. In all the experimental plots the same programme was followed, making as far as possible the same kind of experiments, thus following the principle of multiple experiments which was found necessary at the agricultural experimental stations. The experimental entomological plots should be as far from one another as possible and cover the entire region. The Tula Station has always followed these principles in studying the insect pests of this region.

Among these insects, special attention was paid to:—

1. *Euxoa segetum*,
2. Hessian fly,
3. Frit fly, and
4. Clover pests, *Apion spp.*

Through the work of the station in studying Apions, the Department of Agriculture suggested to the Zemstvo of Tula to call together a special conference to consider clover pests in general in Central Russia. This conference took place March 27-28, 1915.

Kharkov Entomological Bureau:—

On January, 14, 1905, a meeting of the Zemstvo of Kharkov decided to open a credit to defray expenses of entomologists for the study of the life of insect pests in the province of Kharkov for the purpose of destroying them. The Zemstvo invited two entomologists and thus the systematic study of insect pests was started and the local entomological bureau founded. Although the economic entomologist recorded a considerable number of insect pests (altogether 66 species, among them 29 field pests, 28 garden pests, 8 orchard pests and 1 forest pest), with few exceptions no special harm by the pests has been observed during the last few years.

The study of the pests is done by means of excursions made both by the personal staff of the bureau and by the help of local agronomists and instructors.

In order to inform the population of the nature of its work, the entomological and phytopathological bureau has edited since 1913 a bulletin on the subject of agricultural pests, and measures for destroying them. The bulletin is published periodically seven or eight times a year.

To complete the description of the study of insect pests in this province, it must be stated that these matters also constitute part of the duties of the entomological section of the economic station of Kharkov, but this section is not yet fully organized, and is not, for the present, capable of doing any systematic work. The staff of the section (the director and his assistant) succeeded in obtaining a considerable amount of information about the pests found in fields, and particularly the pests found on grasses, also about *Gryllotolpa vulgaris* Sem; at the same time they study the question of methods and the technique of experimental work;

Kaluga Entomological Bureau:—

Kaluga Entomological Bureau was founded in 1912. During the two years of its existence this institution could not develop all its activities. Special attention was paid by these entomologists to garden pests, for gardening plays an important part in the economics of this province. Among the field pests if this province the most important ones are the wire worms *Agriotes lineatus* L. and *A. sputator* L, also *Euxoa segetum* Schiff.

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(1) $12.500,

Kursk Entomological Bureau:—

Established in 1913, this entomlogical bureau studied mostly the orchard garden pests, chiefly the *Aphids, Phytoptus pyri* and Codling Moth.

Voronezh Entomological Station:—

Established in 1912. Observations made in 1912 proved that many insect pests were present, the most important ones in relation to agriculture being *Anisoplia*, Hessian and Frit fly, wireworms, cutworms and *Phlyctaenodes sticticalis*.

Among the insects that injure stored corn, *Calandra granario* attracted the Station's special attention from the first year of its existence.

Orel Entomological Bureau:—

This bureau has existed since 1912, and its personal staff consists of an entomological instructor and a preparator. As most complaints were aroused by the harm caused by Elateridæ, the bureau made one of its chief problems the study of these pests, particularly *Agriotes lineatus* L. Besides this, the bureau made special studies of *Euxoa segetum*, on the genus *Apion*, *Sheimatobia brumata*, and others.

Poltava Entomological Bureau:—

An entomological research experimental institution has existed in the province of Poltava since 1910, namely the entomological section of the experimental station in Poltava (1). The work of this section could not, however, satisfy the growing needs of the peasants for help on the practical questions of applied entomology. The nature of the work would not permit the staff to leave the station to satisfy the demands of institutions or of individuals. This necessity was realised, and there arose the question of inviting an entomologist who would be able to help the population to control the insect pests, and who could make a survey of the pests of the province. Accordingly in 1914 an entomological bureau was established there.

According to the agreement of the Zemstvo of Poltava with the Poltava Agricultural Society, the experimental station offered its premises and its entomological laboratory to the bureau, which from the very beginning made the fullest possible survey of the pests and diseases of vegetation is the province. The Bureau organized for this purpose, first of all, an extensive system of correspondents, and by the end of 1914 the number of correspondents reached 600. The popular papers published were of service in the work of consultation and for the popularizing of entomology. These papers were of three kinds; (a) the type that informed the peasants regarding certain pests and rational means for destroying them. It also indicated the apparatus and materials used for destroying these pests and mentioned firm and warehouses where they could be obtained; (b) In the second type, the bureau showed the method of protecting particular cultivated plants from their pests, giving the same kind of information as the first type, but also summing up all the given facts about several pests of one plant; (c) The third type is the periodical pamphlets which describe seasonal measures for destroying the pests.

Kjazan Entomological Bureau:—

Established in 1915. Among the pests the bureau studied *Aporia crataegi* L., *Psylla mali* Ferst, *Anthonomus pomorum* L., *Phyllotretae*, *Euxoa segetum* Schiff. In 1915, the entomological bureau made observations on the pests of clover, namely *Apion*.

4. South Western Region:—

In this region there are two permanent entomological institutions: the entomological station for protecting plants in Kiev; the entomological bureau of the Zemsvo of Volyn.

Kiev entomological Station was instituted in 1901. (2).

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(1) Organized and conducted by the late N. Kurdjiemov, most brilliant of Russian entomologists.
(2) Under Professor V.P.Pospelov, at present Director of the Central Bureau of Entomology, Petrograd.

During the existence of this station, it has accomplished the following principal works:

1. The control of *Bothynoderes punctiventris* Germ (pest of sugar beet). (At the same time, observations were made on the chief features of the life of this pest).
3. The control of *Euxoa segetum* Schiff in beetroot plantations.
3. " " " *Oscinis frit* L.
4. " " " *Cecidomyia destructor* Say.
5. " " " *Phlyctaenodes strictacalis* on beetroot plantations.
6. " " " *Siphonophora pisi* Kaltenbach.
7. " " pests of gardens.
8. " " forest pests.

Also the station made many observations on a number of other insect pests, which greatly increased its knowledge of their life histories.

Special attention was paid by this station to the control of insect pests by the parasitic method, while from the very beginning, it was obliged to give attention to the insects that injured stored products.

In 1912, the station, with the financial support of the Department, organized the 3rd International Conference of Sprayers.

In Smela, also in the province of Kiev, there has existed since 1901 a *Myco-entomological experimental station*, supported by the All-Russian Sugar Planters Association, which is occupied in studying pests and diseases of sugar beet, and other cultivated plants involved in the beet culture; also of weeds, for it is on them that the pests and diseases of cultivated plants are usually developed.

The purpose of these observations was to discover preventive measures and means for destroying the insects and diseases.

Volyn Entomological Bureau:—

Established in 1913.

Unfortunately the war, especially in 1915 when one-third of the province was occupied by the enemy, absolutely prevented the development of the work of the Bureau. In spite of all these unfavourable conditions, the bureau in 1914 and 1915 made observations on quite a large number of pests of fruit and orchard plants; also on pests of hops, beetroot and other crops.

5. Southern Region:—

This region is provided with four entomological organization:—1. The Bio-entomological station in the Zemstvo of Bessarabia; 2. Entomological section of the Department of Agriculture in the Zemstvo of Ekaterinoslav; 3. Entomological organization in the Zemstvo of the Crimea; 4. Entomological Station of Kherson.

The oldest of these entomological organizations is that of the Crimea; then follows that of Kherson; after that, that of Bessarabia; and lastly that of Ekaterinoslav.

Entomological organization in the Crimea:—

The functions of the entomological bureau in the Crimea are performed by the local museum of Natural History which was established at the suggestion of the entomologist I. A. Mokzzhecky, who was invited to fill the post of economic entomologist soon after its establishment by the Zemstvo on June 10, 1893. The Chief reason for establishing this post was the appearance in the Crimea in 1891 of a new insect *Eurygaster maurus*, which was not then known. and which in 1892 destroyed about 60,000 acres of wheat in the district of Theodossia.

The duties of this entomologist are:

1. Observations on insect pests in places where they appear, and the organization of measures to destroy them.
2. The organization of observations on insect pests in their natural surroundings.
3. The organization of experments for testing one or other measure for the destruction of field and garden pests; the testing of different insecticides; and experiments for testing other methods of keeping plants healthy and destroying pests, such as fumigation, parasites, etc.
4. Consultation work, which consists of giving verbal or written advice to owners in reply to their questions concerning the destruction of insect pests.

(1) At present in Poland.

5. The organization of courses, discussions, and lectures, on the subject of economic entomology.
6. Scientific literary work which consists of recording the information obtained on the biology of insects and of observations on their life history.
7. The care of the local Museum of Natural History.

The work of the economic entomologist relative to the finding of the best measures for the destruction of local insect pests, resulted in recognizing as the best, the chemical method, or spraying with poison those plants which serve as food for the pests. In 1894 the economic entomologists first made experiments by spraying orchard-gardens with a mixture of Paris green and lime; and of Bordeaux mixture and Paris green. In 1896, in co-operation with the Gardening Society, a booklet was published on the use of Paris green (this was republished several times). A large amount of Paris green with copper sulphate was obtained, and American sprayers were bought. In the spring of 1896 the method of spraying fruit trees with the mixture of copper sulphate and Paris green was used in many orchard-gardens, and it gradually spread throughout the whole of the Crimea.

Among other insecticides which were first used in the Crimea must be mentioned the so-called "gypsin" (lead arsenate), which was used under this name, thus replacing Paris green.

Also a great deal of attention was paid to the fumigation of plants with cyanide gas for killing the insects; attention was also paid to the parasitic method of destroying insect pests.

The results of the study of the insect pests were published in the yearly report of the work of the entomologist.

The work of the economic entomologist, which lasted 23 years, resulted in the publication of over 200 papers on these subjects.

Kherson Entomological organization:—

This organization ,represented by an economic entomologist from the very beginning of its existence, made systematic observations on the pests that appeared in the province, which were reported in the yearly "Review of the enemies of agriculture in the province of Khersonsk", by T. K. Pachovsky, the economic Entomologist.

A special characteristic of this organization which is closely connected with the museum of Natural History in the Zemstvo of Khersonsk, is the study of not only the injurious insects and animals but also of weeds, and the economic entomologist, (who is also the superintendent of the museum), has published many papers on this question. According to the yearly "Review ", the last few years can be considered to have been fortunate ones for, with the exception of *Cephus pygmæus* which appears nearly every year in the province, other species of crop pests that are usually found in the province, have not been observed.

Among the pests that are usually found in the province are *Anisoplia austriaca* Herbst., *Euxoa segetum*, Schiff, *Adelphocoris lanceolatus* Goex, *Epicometis hirta* Roda, *Phytoptus piri* Sor. all of which appear in some places in considerable numbers.

Bio-entomological station in Bessarabia,(1) established in 1911:—

Among the insects and parasites found in the province of Bessarabia, the station made a particular study of the pests and diseases of vineyards, and among them special attention was paid to mildew and the means of controlling it.

Besides this, mention must be made of work on controlling the larvae of *Athalia spinarum* and the big experimental work relating to the control of *Lema melampa* L, and *Cheimatobia brumata* Lin.

For the widest possible diffusion of knowledge regarding measures for the destruction of garden pests among the population, the station devoted a considerable amount of attention to the work in demonstration gardens, in the gardening regions in the province of Bessarabia.

Ekaterinoslav Entomological Bureau:—

Established in 1914.

Among the field pests in the province of Ekaterinoslav, *Ozia (Tapinostola) muscutola* Hûbn, was of special importance owing to the harm done by it in 1910-1914 throughout nearly the whole of the province.

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(1) Now part of Roumania.

6. South Eastern Region:—

In this region there is only one entomological institution, namely, the Astrakhan Entomological Station.

The region of Astrakhan, where the cultivation of gardens, vineyards and orchards has been greatly developed, has always suffered greatly from many different pests. This loss attracted the attention of the Astrakhan Society of Gardening, and ever since the Society was founded, at its request entomological specialists were often sent to the province from the Ministry of Agriculture for the purpose of studying local insect pests, and finding the most rational means of destroying them. But usually the entomologists could not remain long in the province, consequently they could not devise efficient control methods for the agricultural pests, Therefore, in 1907, the Society asked the Department of Agriculture to establish a permanent Entomological Station in connection with the Society, which began to work systematically in January 1912. (1)

The first two years of the work of the station coincided with the appearance of hordes of *Phlyctaenodes sticticalis* and locusts. The station took an active part in destroying these insects,and began the application of the chemical method of spraying on a large scale. The work of the station during those two years was of a purely practical character, and very little time was left for making observations on other pests, or for getting acquainted with the general condition of the province. The personal staff performed this useful work in different districts of the province and by the end of the third year, observations were finished and the pests of the province were more or less known. Besides, the station had by this time become acquainted with the local conditions, and knew the proper measures for destroying the insects in every part of the province. The work of the station was mostly concentrated upon the pests that injure vineyards, orchards and gardens. At the same time some attention was paid to the pests found in fields. First of all were studied those pests which did considerable harm, but which were unknown in entomological literature. Such pests were: 1. Pests of mustard; 2. *Birton hirtarius;* 3. *Galerucella fenella* L, a pest of strawberries; 4. Caterpillars of *Talis quercella* Schiff, found in the steppes in the district of Zare··; and others.

7. Stavropol Entomological Bureau:—

The principal reason why the Stavropol Entomological Bureau was founded was the huge loss caused to the province of Stavropol by hordes of locusts, the chief of which were the *Dociostaurus maroccanus* and *Locusta migratoria.* The idea of establishing a permanent entomological station was first discussed at a meeting called for this purpose on the 18th October, 1910, in Stavropol, but no definite decision was then reached. But the question was discussed again, with the result that an entomological bureau was established in Stavropol in 1912 (2). The reason why an entomological bureau was established, (whose organization stood nearer to the field work) instead of a scientific experimental organization, such as an entomological station would have been was the desire to make the staff of the bureau take part in the work of destroying the pests, chiefly the locusts, for this work could be successful only when directed by persons fully competent for such a task. In fact the principal task of the staff of the bureau during the first two years of its existence was the organization and working out of measures for destroying the swarms of locusts.

In 1913 it became possible to make certain special observations. The entomologist of the bureau,B. P. Uvarov, finished the work on the morphology and taxonomy of two species of *Locusta* L. (3) The assistant entomologist, V. A. Glazonnoff, completed the study of the comparative anatomy of the larvae of *Cephus pygmaeus* L., and *Trachelus labidus* L.

The gathering of information about the local pests was considered very important by the bureau, and from the first year of its existence it made a f ll record of not only those pests which undoubtedly did harm in the province of Stavropol, but also of those which had not yet been for some reason, (for example, the insufficiency of observation owing to their small numbers) considered as serious pests in the Province, but which might be potential pests.

8. Turkestan Entomological Station:—

The most injurious agricultural pests in Turkestan is the Moroccan locusts, (*Dociostaurus maroccanus*), which owing to the failure of the mechanical measures used to destroy it, necessitated

(1) Under N. L. Sacharov.
(2) Under B. P. Uvarov, who remained there until 1915.
(3) Which resulted in a new theory of periodicity and migration of locusts (see Bulletin Entom. Research, London, XII, 1921).

in 1890 the calling of a conference of entomologists in order to find a more effective means of destroying it. There also arose the question of a permanent organization to take charge of those measures, and of a systematic study of locusts and other insect pests. As a result the local authorities conceived the idea of establishing an entomological station, which started its work in the spring of 1911. (1)

The programme of the work of the station may be outlines as follows:

The entomological station is an establishment of an applied character; it studies the locusts and the biology of other insect pestsof Turkestan, and also takes part both in organizing and in working out measures for destroying them, by means of directing and handling ,respectively, protective and destructive measures.

As the most important aim of this entomological station was the study and organization of measures to destroy the insect pests of Turkestan in general, the station made use of all its available scientific force for organizing rational measures of destroying the Moroccan and other locusts.

The station studied the local locusts, their breeding places, distribution throughout the region, time of their spring appearance, stages of larvae, their manner of life and habits, their natural enemies, laying of eggs, infection of the latter with parasites, etc. Owing to such detailed knowledge of local locusts ,it was possible to try new measures for their destruction with a greater confidence, and to organize measures that would come up to modern standards of scientific knowledge on this this subject.

The second in importance among the pests is the Codling moth, which does enormous harm to the increasing industry of orchard-gardening, and serious attention was paid by the station to this pest.

In addition the station studied other pests of gardens and vineyards, investigated their distribution in the region, and tested effective measures for destroying them.

The station also studied the pests found in fields and market gardens, and paid special attention to the pests of hops and beetroot which are the most valuable among the cultivated plants of the province.

The study of agricultural pests in the province of Turkestan shows that most of the pests found there are the same as those found in middle and southern Russia. One must, however, note the absence of *Phylloxera,* and of *Melolontha melolontha* L. in Turkestan which is replaced by *Polyphylla adspersa,* the destruction of which is even more difficult.

The insect pests found only in Turkestan, are the following: *Agelastica orientalis* Baly and *Pachydissus sartus* Sols, which do great harm chiefly among the forest trees used for building. Among the orchard-garden pests, the most serious one is the Codling moth which spoils and destroys many pears and apples. Quite as much harm is caused by *Grapholitha funebrana* and *Rhynchites auratus.* During the last few years the activity of the woolly apple aphis has also been noticed.

The results of the work of the station on the subject of insect pests have been recorded in a number of papers and memoirs.

RUSSIAN ENTOMOLOGY SINCE 1914.

Reference has already been made to the rapid development of applied entomology by the establishment of a large number of entomological stations throughout Russia from 1895 onward. Up to 1910 such stations had been established in four southern provinces, but in 1914 there were 21 stations. During the first years of the War the number of stations was increased, for the authorities saw the necessity of increasing the products of the farms, and to preserve them from severe outbreaks of insect pests. In Transcaucasia bureaus were established at Tiflis, Elisavetpol, Baku and Kutair, where an organization on a very extensive scale was established under the charge of B. P. Uvarov. Each bureau consisted of three sections, entomological, phytopathological and zoological (for the control of rodents.) The Tiflis bureau gave most attention to orchard pests, to moles, and the pests of tobacco and vineyards; besides,it accumulated much material and information on the insects of Transcaucasia. The

(1) Under V. I. Plonikov, still in charge of the station.

bureaus at Elizavetpol and Baku concerned themselves chiefly with locust control.

During the same period (1914-1917), local organizations were formed at Rostov, Saratov, Vladikavkaz, Ekaterinodo and in Siberia, while existing stations were enlarged.

After the Revolution of 1917, the stations in the outlying provinces which had proclaimed their independence, namely the Baltic States and the Caucasian republics, were cut off entirely from Russia proper. In most cases these provinces had a non-Russian population and the lot of the Russian specialists in the stations was not an easy one, for the new national authorities maintained an attitude of suspicion against them as Russian "oppressors", and required of them a knowledge of the native language. The lot of those entomologists, however, who remained in Russia proper was still worse, and the Red Terror, civil war, typhus and starvation have taken away many of them, including several leading specialists. Besides, the new, ignorant, often illiterate Bolshevik authorities at first paid little attention to the agricultural, being occupied with the political struggle. As a result, the entomologists, and for that matter the entire Russian educated classes, had to earn their living by making shoes, doing clerical work, or working on farms and at the docks. Even the few men who remained at the stations at their posts were obliged to grow vegetables to stave off starvation.

Under such conditions, where the large tracks of uncultivated land favoured the increase of pests, and when control measures were almost wholly neglected, the country during 1919-1921 was overrun with locusts, rodents and many other pests which appeared in enormous numbers in districts hitherto exempt from the attack. The losses were so great that the Soviet authorities began an enormous programme of entomological work to save the crops and the people, and stations were established in almost every province —often in their sub-divisions. But it was more easy to pull down than to build up. Qualified men could not be found at this time for the new posts. Instead, young men without any qualifications were placed at the stations, and the pests continued their ravages. However, it must be said that the money appropriated for the up-keep of the stations was totally inadequate on account of the great decrease in the value of paper money. Moreover, there was great difficulty in getting the money through the complicated and entangled systems of Soviet "red tape".

One excellent result was the recognition of the economic entomologists as useful members of the population, In point of comfortable living, however, they were not much better off than before: their anti-locust work had to be carried on with a miserably small amount of money which had to be extracted after the expenditure of much time from numberless ignorant authorities. In spite of the handicaps, many of the economic entomologists made good; they cleared vast tracts of Siberia and other provinces from locusts by the adoption of the poison bran bait on an enormous scale. Most of the unsuitable men gradually fell out and the position of the conomic entomologists was strengthened when the authorities began to see their value and realized that success did not depend upon mere numbers of stations and men but upon the quality of the men and adequate funds and materials.

With the deterioration of Soviet finances began a new movement—the reduction of the number of local stations, closing first of all those opened after the Revolution. Unfortunately some stations that had excellent staffs suffered much reduction, while others that were doing poor work were kept intact due

to "bluff". The reducing process is still in operation, and the future is full of uncertainty.

The purely scientific entomologists—members of museums, professors, specialists in Experiment Stations —have fared worse, since it was not easy to prove to ignorant authorities the necessity of pure research without immediate practical application. Accordingly the losses in pure entomology have been very heavy. Some were obliged to turn to economic work, where the pay was greater, but in spite of the very hard conditions of life, many have kept bravely at their posts. When it is realized that a university professor's salary is about L4. a month, while the cost of living is higher than it is in London, it is remarkable how these men were able to keep body and soul together, with miserable rations of food, and to prosecute their scientific studies, often in unheated buildings in winter without artificial light. An enormous number of unpublished manuscripts prepared by the museums and societies are ready for the printer, but no money is available.

The Russian scientific workers have shown a devotion akin to martyrdom; they did not abandon science when conditions of life became scarcely bearable, but science served them as a refuge from the grim realities of life.

MOST IMPORTANT RUSSIAN ENTOMOLOGICAL WORKS

I. Periodicals and serials.

1. *Horae Societatis Entomological Rossicae 1958-1919.* (Temporarily suspended owing to the lack of funds). Vols. I-XLI. Pretograd. Published by the Russ. Ent. Soc.
2. *Revue Russe d'Entomologie 1901-1922.* Vols. I-XVII. Petrograd. Published by the Russ. Ent. Soc.
3. *Messager Entomologique.* Vols. 1-11, 1913-1914. Kiev. Published by the Kiev Society of Friends of Nature.
4. *The Journal of Applied Entomology.* Vols. 1-II. 1917-1818. Kiev. Published by the Russian Association of Applied Entomologists.
5. *Entomological Messenger.* Kiev. (Contained only reviews of current Russian literature on applied entomology).
6. *Memoirs of the Bureau of Entomology.* Vols. I-XII. Petrograd . Published by the Bureau of Entomology of the Ministry of Agriculture (now Section of Applied Entomology of Agricultural Research Committee). Contains a most valuable series of monographs of very many important injurious insects; each monograph published as a separate part and there are about 10 parts in each volume.
7. *Reports of the Bureau of Applied Entomology.* Vols. I-II. 1921-1922. Petrograd. Published by the same institution and intended to include smaller papers, all the larger ones being published in the *Memoirs.*
8. Numerous reports of the local entomological institutions, proceedings of entomological and entomo-phytopathological conferences, etc.

II Handbooks and General Works.

1. N. A. Cholodkovsky. *A Course of Entomology, Theoretical and Applied.* St. Petersburg, 1912. 3rd edition. (An excellent general handbook.)
2. N. M. Kulagin. *Injurious Insects.* Moscow. (Three editions. Published 1904-1923. Contains extensive information on Russian insect pests.)
3. N. N. Bogdanov-Katkov. (Under his editorship, but by several authors). *Practical Entomology.* Petrograd. 1921-1923. (Published in parts by different authors; so far only four parts are out).
4. Köppen, Th. *Injurious Insects.* 3 vols. Petrograd. 1980. 1545 pp. (An enormous amount of information on Russian economic insects; still very valuable though out of date; out of print.)

5. K. E. Lindeman. *General Foundations of Entomology.* Petrograd. 1902. 628 pp.
6. B. P. Uvarov. *Agricultural Entomology; Insect Pests of Georgia and their control.* Tiflis, 1923. 234 pp.
7. V. I. Plotnikov. *Insects Injurious to Agriculture, Horticulture and Market-Gardening in Turkestan, with Indications as to their Control...* Tashkent.. Published by the Turkestan Entomological Station 1914. 216 pp.
8. David Sharp. *Insects,* 1910. (Translation by N. Kuznezov, of the well known book with many additions; much more complete and up-to-date than the original).
9. J. Porchinsky. *Insects Injurious to Fruit Gardens in the Crimea.* 1889.
10. A. F. Rudsky. *Insects Useful and Injurious to Fruit Trees.*

III. Books on Taxonomy.

1. G. G. Jacobson. *Beetles of Russia and of Western Europe.* 1905-1917. Petrograd. 1034 pp. 52 coloured plates. (A complete catalogue, with synonyms and distribution of the whole Palaearctic fauna. including China, Central Asia and Japan. Published in 11 parts—one more remains ,but publication temporarily suspended since the publishers' firm has been nationalised; the manuscript is complete, with the author, who is a member of the staff of Zool. Museum of the Academy of Sciences, Petrograd.)
2. G. G. Jacobson and V. L. Bianchi. *Orthoptera and Pseudoneuroptera of the Russian Empire.* Petrograd. 1905. 952 pp. 25 coloured plates. (A complete monograph of the orders indicated for the whole Palaearctic region; the work is based on Tümpel's *Orthoptera of Middle Europe,* but contains a great amount of material not in the original. By far the best book or Palaearctic Orthoptera existing in any language).
3. N. M. Romanoff. *Mémoires sur les Lépidoptères.* Petrograd. 1884- 1901. 9 vols. in 4; Contains a large series of most important monographs and papers by the best lepidopterists of the time).
4. Several large German books on Lepidoptera, (Lampert, Berge, Hoffman) have been translated and published, partly with important supplements on Russian fauna. Books by J. Fabre, Lubbock and many others also exist in very good Russian editions.

IV. Miscellaneous publications:

1. Reports and other publications of local stations, too numerous to mention.
2. Papers in general agricultural press.
3. Separate publications by the Department of Agriculture, Department of Forestry, etc.

Almost all Russian economic publications since 1913 are regularly reviewed in the *Review of Applied Entomology.*

DR CHARLES EUSEBE DIONNE, NATURALIST. 1845-1925

By Dr. A. Dery and S. Matte of the Provancher Society of Natural History, Quebec.

In the death of C. E. Dionne, which occurred on January 25, 1925, the world of natural science lost one of its finest personalities. Almost unknown, and humble as all true scientists are, he progressed and became, by dint of effort, perseverance and courage, one of the leading ornithologists of his country.

His death is a severe loss to scientific societies and to sportsmen, but especially to Laval University, where his place will be difficult to fill.

Charles Eusebe Dionne, son of Pascal Eusebe Dionne and Emilie (Lavoie) Dionne, was born on July 11, 1845, at St. Denis, Kamouraska County, Quebec. His father was a farmer of limited means.

As a boy he attended, not too regularly, the parochial school at St. Denis, until he reached the age of 11. When very young, he loved to wander through woods and fields and along the shores; his interest in things relating to natural history, such as plants, insects, and birds, was being developed through contact with nature herself.

He was especially attracted by groves and by a certain swamp behind his father's house, in which he used to see the Maryland Yellow-throat, a bird which particularly attracted his attention as a beginner.

When he left school, he remained on the paternal farm till he reached the age of 15. A little later he went to school again for two different periods, totalling thirteen months. The teacher, Mr. Guillaume Robichaud, taught a special class of two pupils, to which, as a favor, young Dionne was admitted, but as a listener only, not being given the right to put any questions. Soon, however, the teacher noticed his application as well as his eager desire for learning, so that he treated him just as he did the other pupils. His progress was so remarkable that one day Mr. Robichaud, referring to him, said, "See young Dionne; he has learned in thirteen months what most of the others require four years to learn".

This special class furnished him an opportunity of seeing for the first time a text-book on natural history. Having seen the coveted book on a shelf and being too timid to ask for it, he had recourse to a stratagem to snatch it, study it, and replace it as it was. Shortly afterward, the teacher, having discovered his doings, amicably reproached him for his timidity and placed the book at his disposal. Dionne read and reread the volume and copied all the figures therefrom.

One of his brothers was an employee at the Quebec Seminary. Charles decided to join him and on January 19, 1865, he was appointed a campus employee at a salary of $4.00 per month plus room and board with the students. But after the fire of March, 1865, he was given work in the kitchen.

There was then a museum at Laval University (closely associated with the Seminary), but rigid rules forbade all employees to enter it. Young Dionne did not even know that it existed.

In September 1866 he was appointed, apparitor in the Faculty of Law of Laval University with free access to the library. In such proximity to the museum Dionne became aware of its existence. He also began his botanical studies by means of books from the library. His first author was Buffon. The following year saw the beginning of his collection of birds. His collection of insects was also commenced about that time, with the encouragement and advice of Mgr Hamel.

The only time which he could devote to his study and the work of forming his collections was that after the close of his day's work as an employee and what he could spare at lunch time and he almost had to hide to use even these hours in his favorite way for fear of ridicule from his fellows-employees.

The Rector, Mgr Hamel, took much interest in his studies and would periodically come and chat with him, observe his progrees and encourage him. Abbé Lavcrdière, just before be died, strongly recommended that the authorities of the Seminary should held young Dionne and facilitat· his studies by giving him the necessary freedom of action.

About 1867, he attended an evening course of in·truction given by Mr. Cloutier at the old Normal School. He found it difficult at first to obtain permission, as this class ended too late in the evening to allow him to return to the the Seminary building before the closing of the doors at 8.45 p.m. Far from being discouraged by the Proctor's refusals he submitted his request to the Rector, Abbé (later Cardinal) Taschereau, who not only granted his wish, but gave orders that a door should be left open every night until his return. The following year he was able to continue his evening course at the Brother's Academy, under the direction of Abbé (later Mgr) Gauvreau.

On May 6, 1876, he married Marie Emilie Pelletier.

In 1882 he was appointed Curator of the Museum of Laval University At that date the Museum contained but a small fraction of its present wealth, and most of the specimens in it were neither named nor classified . Mr. Dionne' first ambition was to establish order. Single-h nded, he accomplished this task so well that it will always remain the most worthy monument to this memory; a monument full of precious lessons for the information of generations to come. The board of directors of that period had truly made a happy choice in appointing Mr. Dionne as Curator.

All of Mr. Dionne's outings were devoted to collecting; he would visit the woods in the vicinity of Quebec, such as those at Sillery, Charlesbourg, and around Chateau Bigot, as well as the shores at St. Denis, Rivière Ouelle, and Chateau Richer. Unfortunately, the time at his disposal was very limited and holidays were few. A determination such as his, coupled with a decided love of his work, alone explains his persistance in following his favorite studies notwithstanding the difficulties imposed by chance and circumstances. "In spite of that", he would say, a short time before his death, "if I were to start all over again, and if I saw in advance all the obstacles which I had to conquer. I would not hesitate to choose the same path".

In 1889 he collected at St. Denis specimens of the Acadian Sharp-tailed Sparrow (*Passerherbulus nelsoni subvirgatus*), which had recently been described by Dr. Jonathan Dwight, Jr., of New York, from specimens obtained in the Maritime Provinces. Soon afterward Mr. Dionne published his records of this bird in his *Catalogue annoté des oiseaux de la Province de Québec*. Some time later Dr. Dwight, who had read this publication, sought for the Sparrow in question in various marshes along the St. Lawrence (but not at St. Denis) but without success. So he went incognito to see Mr. Dionne and questioned him concerning the bird. This disclosed his identity, since no one but Dr. Dwight could put such questions. Mr. Dionne's specimens were therefore shown and

his identification confirmed. Dr. Dwight has held him in high esteem ever since.

Mr. Dionne learned taxidermy from books, but, as a result of his constant striving for improvement and his observation of nature itself, he found methods that were often more efficient and practical than those previously employed.

In spite of a great loss sustained in a fire in 1917, Mr. Dionne's private collections are very valuable. Space does not permit of mentioning them in detail here, but they include, many birds and mammals, butterflies and other insects, as well as a herbarium.

Mr. Dionne's main travels are the following:

In 1882 he was invited to take part in an expedition to the lower St-Lawrence on board the Druid in company with Mr. J. U. Gregory, an agent for the Canadian Department of Marine. The object of the excursion was to make certain studies and observations on game.

He went in Chicago in 1893 and attended the opening of the Field Museum. In 1900 he visited the American Museum of Natural History, at New York. During a trip to Europe in 1912 he visited the Jardin des Plantes, the Musée d'Histoire Naturelle and the Musée d'Anatomie, in Paris, and the British Museum, in London.

Besides various scattered notes and articles in scientific periodicals he published the following works; Les oiseaux du Canada, Catalogue Annoté des Oiseaux de la Province de Québec, Les Mammifères de la Province de Québec, Les Oiseaux de la Province de Québec, Les Araignées. All of these works are recognized authorities in their respective fields.

A Master of Arts, he was made a Doctor of Science a few days before his death, at the completion of sixty years spent by him in the service of Laval University. He was a member of the National Geographic Society and had been a fellow of the American Ornithologists' Union since 1893. He was one of the founders of the Provancher Society of Natural History.

His field of action was not limited to the fauna of his own country; in fact, he made, with scientists of all countries, thousands of exchanges of specimens of insects, bird skins, and plants, thus helping greatly to make our national treasures of natural history known in foreign lands.

An amateur inquiring for information or bringing specimens for his inspection was sure to receive every possible assistance, given in the kindest and most gracious manner. In this excellent fashion Mr. Dionne popularized natural history among the people of his province.

Dr. C. E. Dionne was assuredly not a closet-naturalist and his knowledge was not merely book knowledge, for he studied from nature's great open book.

THE OUTBREAK OF THE GIPSY MOTH IN SOUTHERN QUEBEC

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So much has been written and said about the Gipsy moth situation on the North American continent, much of which is undoubtedly familiar to the members of this Society, that it will be necessary only to review the history of this insect in the briefest manner. It was in the early sixties of the last century that a French scientist, living in the vicinity of Boston, imported some egg clusters of the Gipsy moth from Europe with the intent of crossing this insect with native silkworms. Some of the material escaped, and although the matter was brought to the attention of entomologists and others through the medium of the scientific press, no action was taken to investigate the situation. More than twenty years were required for the insect to become established and for the caterpillars to become so abundant as to receive public notice. Control measures were inaugurated and by about 1900, the infestation had been so reduced that the officials in charge were in hopes that the eradication of the pest was not impossible. In spite of the vigorous protests of the entomologists, who were anxious for the control work to be carried on for a few more years in an endeavor to eliminate the insect, the state legislature refused to appropriate any further funds and the work was closed down. By 1905 the insect had increased to such an extent that it was imperative to recommence control operations in the field if the forest, shade and fruit tress were to be saved. A field survey of the infested territory showed that the insect had spread over twenty-five hundred square miles, and it was then realized that there was no hope of exterminating the gipsy moth from Massachusetts.

From that time the insect has been gradually spreading in all directions, but particularly in a north easterly direction, like an ever encroaching sea, in spite of the millions of dollars that have been spent by the federal, state and civic authorities as well as private individuals in an effort to stem the tide.

Canada has been keeping a close watch of the situation, and entomologists realized that it was only a question of time before the Dominion would be invaded. There appeared to be two vulnerable points in Canada where an infestation of the gipsy moth, due to natural spread from the United States, was likely to occur, one was in New Brunswick through the state of Maine, and the second, in the eastern townships of Quebec through New Hampshire or Vermont.

In the fall of 1922 an international conference was held at Albany, New York to discuss the gipsy moth situation. Officials actively engaged in the gipsy moth control work and others in adjoining states who were intensely interested in the problem, as the pest was gradually approaching their territory, decided that it was necessary to review the entire situation and try to work out

some definite scheme of control. Furthermore, it was appreciated, that with the increase in the size of the infested territory, there was a corresponding increase in the amount of money necessary for control work, and it would not be long before sufficient money would not be appropriated for this work. As a result of the conference , a barrier zone was to be established twenty five miles in width and extending from the international border to Long Island Sound. All territory in this area was to be kept free from the gipsy moth.

Canada was naturally very interested in this policy, especially as in 1912 the nearest colony of the gipsy moth was only ten miles from the Quebec border. During the summer of that year two Federal scouts made a hurried survey of the eastern townships, and as a result of the conference held in the fall of that same year, a more extensive scout of this same area was made the following summer. In the fall of 1923, just as the scouting work in Quebec was being completed, the most severe outbreak of the gipsy moth ever found in New England, was discovered at Alburgh, Vermont, within one half mile of the Quebec border. Scouting operations were immediately renewed in Quebec, particular attention being paid to the territory immediately north of the Alburgh outbreak, in the seigneurie of Foucault, but with no result.

Plans were however, instituted to carry out intensive scouting in southern Quebec in 1924. The necessity of this work being emphasized by the discovery of a number of outbreaks in the so called "Barrier Zone" in New York state. The Province of Quebec became actively interested in the problem, as an outbreak of the gipsy moth in the forest areas in Quebec, where artificial control such as spraying would be out of the question, would prove to be a very serious matter. Special appropriations for this work were made by both the Federal Department of Agriculture and the Quebec Department of Lands and Forests. The field work started in July 1924, and approximately thirty-six inspectors were employed from that time until late in November. The territory examined extended from Chateauguay county on the west to Compton county on the east, and to about thirty miles north of the international boundary. This area was divided into eight districts, and a foreman and three scouts were placed in each district.

On July 29th the first record of the gipsy moth in Canada was established by the discovery of a single egg cluster, near the village of Beebe, in Stantead county. This cluster, after careful examination was found to be infertile. Five weeks later a severe isolated infestation was discovered on the Belle Vallée road, Lacolle township, St. Johns county. It is interesting to note in this connection that the Belle Vallée infestation was found on the next road west, to where the work stopped the previous season.

Intensive scouting in the immediate vicinity of the outbreak, shows it to be confined to four farms on both sides of the road and covering approximately one third of a square mile. Control work consisting of creosoting the egg clusters was started soon after the discovery of the infestation and a total of 2,694

were so treated. About seven hundred of these were found on an old willow tree, and over a thousand in a stone wall adjoining it, the balance were scattered through adjacent orchards, on farm buildings, fences, etc. In addition old apple trees full of cavities likely to contain egg masses were cut down and burnt, and in others the cavities were filled, brush was cut and burnt. Extensive "clean up" work will be carried on in 1925, consisting of the thorough rescouting of the entire district, spraying the whole area with arsenate of lead, banding and tanglefooting of trees in the immediate vicinity of the outbreak, and the burning over of the stone walls at the time the caterpillars normally hatch.

It is the intention of both the Federal and Provincial Departments to exert every effort possible to eradicate the gipsy moth from Canada. In addition to "cleaning up" the Belle Vallée infestation plans are under way to carry on extensive scouting in all territory south of the St. Lawrence river. The wisdom of adopting this policy can not be over-estimated in view of the previous history of this insect. The federal appropriation in the United States for control work amounts to seven hundred and fifty thousand dollars a year, and fully as much if not more, is spent annually by the various state governments and civic authorities.

A severe outbreak of the gipsy moth was discovered in New Jersey a few years ago; during the first season over three million egg clusters were found. As the result of a very vigorous campaign by both the federal and state authorities, it appears as if the pest will be eradicated from that state. Numerous other outbreaks have occured in different parts of the United States but all of these have received prompt attention, with the result that the insect has been exterminated in those localities.

Experiments conducted on the effect of low temperatures on exposed egg clusters, gave us hope that the gipsy moth would not prove to be a menace under Canadian conditions, but the situation at Belle Vallée has demonstrated that under some conditions at least, an outbreak of this insect can not be viewed without alarm.

In an endeavor to prevent the spread of the insect in the egg stage, an embargo has been placed on southern Quebec, prohibiting the movement of Christmas trees and greens from some areas, and restricting it from others. The territory involved is one in which under normal conditions, large quantities of Christmas trees are cut for both the local and export trade. Unfortunately it is not feasible to examine these trees in quantity for freedom from infestation, consequently it was necessary to pass this regulation. It is to be regretted that it may prove a hardship in certain cases, but it is for the benefit of the country at large and it is the country and not the individual that must be given the first consideration.

OAT SMUT CONTROL IN 1924.

By B. T. Dickson.

Experiments were continued during the season of 1924 at Macdonald College using Liberty oats and both oat smuts. The grain was artificially inoculated as in previous years (1, 2) and treatments were carried out as before.

The grain was treated and sown on May 28th and 29th when the soil moisture content was 15 per cent. Except for a shower during the night of June 2nd, dry hot weather held from the date of seeding for about three weeks. The plants emerged on June 6th—10th, but field germination was considerably reduced by the attacks of a Thysanuran which destroyed the embryo completely. Sparrows also were a constant source of trouble. Yield studies were thus out of the question and this was further the fact because of very wet harvest weather.

Counts by heads were actually made of every plant which came to maturity The plots were replicated three times and each plot consisted of three rod rows.

The following summarizes the treatment and counts.

It will be noticed that dust treatments were best for the season as far as smut control is concerned, the results being:

Oat Smut control counts.—1924.

	Rep. 1		Rep. 2		Rep. 3		Totals		
Treatment.	H.	D.	H.	D.	H.	D.	H.	D.	% Smut.
Check	376	493	415	581	429	678	1220	1752	5.84
Semesan Dust	582	53	724	50	868	45	2174	148	6.0
Nickel hydrate (calc. ppt. (D)	1109	21	819	23	997	26	2925	70	2.5
Nickel sulphide	985	3	698	12	918	7	2601	22	.8
CuCO3 (N)	892	23	657	10	852	19	2401	52	2.1
DuPont 13	478	264	612	327	754	435	1844	1026	35.7
NiCO3 (D)	623	37	851	39	881	43	2355	121	4.8
NiCO3 (H. F.G.)	651	10	872	13	894	18	2417	41	1.66
Nickel hydrate Caustic ppt. (D)	706	15	784	17	937	9	2328	41	1.7
Check	429	391	486	697	508	681	1423	1769	55.4
Sem. soak	926	77	874	64	1107	57	2907	198	6.4
Usp. soak	1050	44	831	38	1349	32	3230	114	3.4
Usp. dip	699	130	629	141	708	137	2036	308	12.6
Sem. Dip	578	298	643	183	684	169	1905	650	25.4
Check	566	742	317	484	690	1000	1573	2226	58.6
Form. 20 mins. then dry	673	197	605	126	628	145	1906	468	19.7
Presoak * form	675	10	873	34	829	37	2377	81	3.3
Form. * milk of lime	783	124	814	157	796	151	2393	432	15.3
Check	336	528	418	609	544	815	1298	1952	60.0
Usp. presoak * soak	812	135	896	192	923	263	2631	590	18.3
Usp. presoak * dip	670	271	718	241	741	244	2129	702	24.8
Sem. presaok * soak	845	263	816	234	1255	330	2916	827	22.1
Sem. presoak * dip	609	251	582	283	793	254	1984	788	28.4
Sod. fluoride (0.5%) for 20 min.	307	257	362	281	.....	.....	669	538	44.5
Presoak Sod. fluoride	563	241	624	189	.....	.....	1187	430	36.5
Check	456	623	410	675	598	827	1464	2135	59.3

It will be noticed that dust treatments were best for the season as far as smut control is concerned, the results being:

Nickel sulphide 0.8% smut.
Nickel carbonate (H. F. G.) 1.66%
Nickel hydrate (by caustic pptn.) 1.7%
Copper carbonate 2.1%
Nickel hydrate (by lime pptn.) 2.5%

The checks (inoculated with both smuts but untreated) varied in smut count from 55.4 to 60 percent. It is thus obvious that with hull-less oats nickel salt dusts were very efficacious. The nickel dusts were placed at my disposal by Mr. Geo. Sanders of the Deloro Chemical Company, and were used at the rate of 2 ozs. per bushel of grain.

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MOSAIC OF RHUBARB.

By B. T. Dickson.

In Ju'y 1922 the writer observed three rhubarb plants in a market garden patch near Montreal, which appeared to be mosaic diseased. The plants were dwarfed sufficiently to be noticeable and were definitely paler in general color. The leaf blades were mottled and somewhat savoyed intervenally. Discolored longitudinal areas on the petioles were especially prominent in the reddest plant.

In the spring of 1923 the number of diseased plants had increased to eight and the newly diseased plants were alongside those found in 1922. The latter were still further dwarfed, were more mottled and the general chlorophyll content more reduced.

In the spring of 1924 there was a further increase in diseased plants and accentuation of symptoms of previously noted cases. This year aphids were plentiful on the rhubarb.

Mr. Vanterpool inspected the patch early this season (1925) and found 60% of the plants infected. Dwarfing and chlorosis were very marked. Many leaves were pale green with a few dark green patches here and there on the leaf blade (fig. 1). Inspection for Rumex spp. with mosaic in the vicinity has been negative in result.

Attempts to inoculate healthy rhubarb with the juice from diseased plants either by rubbing or by petiole injection have so far failed. It has not yet been possible to transfer aphids successfully.

Nevertheless I am quite certain that these *Rheum rhaponticum* plants have mosaic and this brief account is given that others interested may be on the watch for similar developments.

THE CRANBERRY ROOTWORM BEETLE (Rhabdopterus picipes Oliv.)

By C. E. Petch,

Dominion Entomological Laboratory, Hemmingford, Que.

Introduction.—This insect has been collected in the Provinces of Ontario and Quebec, at least, as early as 1896, but remained unrecorded as a pest in Canada until 1924. My attention was directed to it on apple trees at Mr. J. Normandin's, Rougemont, Que., where it injured the foliage and fruit. Adult specimens were forwarded to Mr. Arthur Gibson, Dominion Entomologist, and he informed me that they had been determined as *Rhabdopterus picipes* Oliv.

Olivier first described the species in 1808 and placed it in the genus *Colaspis*. Say described it in 1824 under the name *Colaspis pretexta*. In 1859, (1) LeConte edited Say's writings and made a note under *C. pretexta* that it was the same as *Colaspis picipes* Oliv. It is recorded as *Eumolpus metalicus* Koch in Melsheimer's catalogue and it is placed in Dejean's catalogue in *Chalcophana*, a genus of which LeConte had never seen any description up to 1859. In 1892, Horn (2) transferred *picipes* from *Colaspis* to *Rhabdopterus*, a genus erected by Lefebvre in 1885.

This insect and *Tymnes metasternalis* resemble each other very closely and it is difficult to separate them, but in *R. picipes*, the thoracic lobes are absent behind the eyes, the thorax is more sparsely punctured and the metasternum smooth. Horn considers the name *picipes* as misleading, as Olivier's figure shows the insect to have pale legs.

Distribution

The insect is widely distributed throughout the United States and the provinces of Ontario and Quebec in Canada. The following States are cited in the literature read,—Indiana, Utah, Nebraska, Illinois, Dakota, southwestern Texas, Florida, Delaware, Pennsylvania, New Jersey, North Carolina, New York and Massachusetts. There are twenty-nine specimens in the Canadian National Collection, listed as follows,—Trenton, Ont., 3 VII. 1910, (Evans); Western Ontario, (Evans) 3 sp.; Eastern Ontario (Evans) 3 sp.; Prince Edward Co., Ont., 1. VII. 96, (Evans); Ottawa, Ont., 14. VIII, (Harrington) 4 sp.; Ottawa, Ont., 20. VI, (Harrington); Casselman, Ont., 21. VI. (Harrington); Ottawa, Ont., 2. VIII, (Harrington—); Montreal, Que., 26, VI. 1898, (Evans) 2 sp.; Hull, Que., 20. VII, (Harrington); Rougemont, Que., 12. VII. 1924 (Petch) 5 sp.; Alleghany, Penn., 2 sp., Iowa; Unlabelled 3 sp. In Chagnon's list of Quebec Coleoptera it is listed as follows,—Rouville Co., VII, (Chagnon); Montreal and Jesus Isl., VII (Chagnon); Vaudreuil, Co., VII, (Chagnon.)

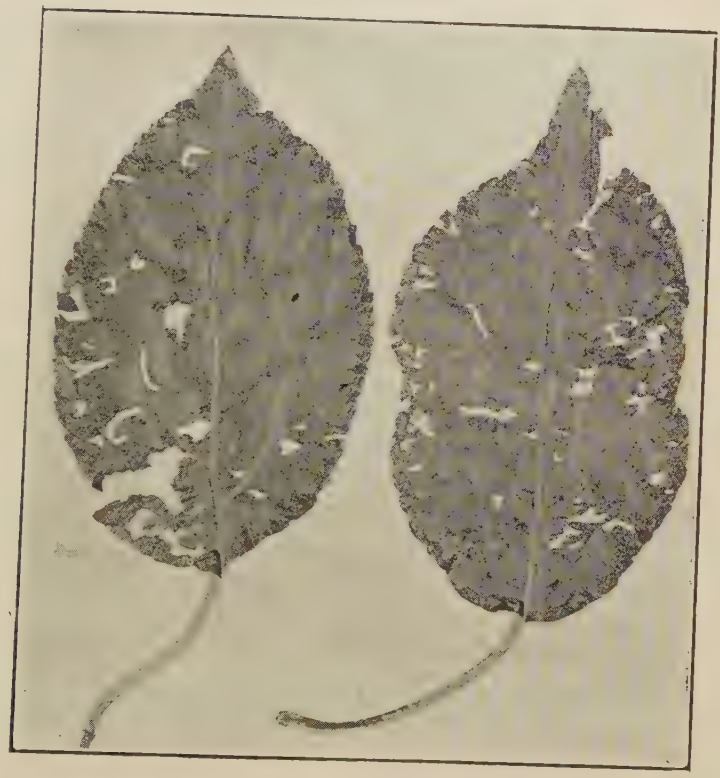
Food plants

The larva has been recorded only from the roots of cranberry but the beetle from quite a few plants. The recorded plants from the United States. are,—myrtle, basswood, grape, foliage and fruit of cranberry, wild grape, inkberry, blueberry, wild strawberry, dock, and fruit of the apple. In Canada it has been collected from alder by Harrington, basswood by Chagnon and apple foliage and fruit by the writer.

Character and extent of Injury

The larvae injure the plants mostly by completely devouring the fibrous roots of cranberry, but, as a rule, only the bark is eaten from the large and se-

Crankerry rootworm Beetle
(R. picipes)—4



Injury to apple foliage.

PLATE II.

Injury to apples

condary roots. The vines which suffer most are those growing on sandy lands. When root feeding is severe, the vines show signs of weakening in the early fall. The leaves dry out, turn red or brown, and the following spring only the dead uprights and runners, bare of green foliage, remain. The feeding on the foliage and fruit of the cranberry is negligible. Scammell (10) found in every instance where the Fulgorid, *Amphiscepa bivittata* Say, was abundant that the vines were in an unthrifty condition, due primarily to other causes, such as attacks from the larvae of the Cranberry Rootworm beetle. Sawyer, (12) (1920) found apples in an orchard near Sodus, N. Y., injured in a very peculiar manner by the adults of *R. picipes*. This is the first record of apples being injured which the author has found. The beetles confined their attack to the fruit, especially Grimes' Golden. About 75 per cent of the apples were injured. Ross, (7) (1916) published a photograph of a peculiar type of injury on Rhode Island Greening apples from the Niagara district. He remarked: "The apples were marked here and there with calloused blemishes, which varied in shape from dots to long, irregular, serpentine areas." Ross forwarded the specimens to Professors Caesar and Parrott, but they were unable to diagnose the trouble. Professor Parrott replied in part as follows: "During the past year we have discovered such injury upon apples, and specimens of peaches have been forwarded to us injured in a manner quite similar. I spoke to Mr. Knight of Cornell University regarding the damage and he intimates that such injuries may attend the work of red bugs". However, basing a decision on the similarity in design of the injury as shown in Ross's photograph in comparison with that found by Sawyer at Sodus, N. Y., in 1920, and by the writer at Rougemont Que., in 1924, it seems very probable that the injury was the work of the Cranberry Beetle. The author's attention was called to a peculiar injury to apples in an orchard near Rougemont, Que., on July 12, 1924. The orchard contained about 2,000 trees, mostly of the Duchess variety and the land was in sod. The injury was very extensive and was present on 50 per cent of the fruit and a large proportion of the leaves. Shallow, irregular channels were eaten out of the surface of the fruits, which sometimes comprise most of the apple (see fig. 1). The leaves are also attacked and portions of them are eaten as illustrated in figure 2. The immediate flora did not indicate the origin of the outbreak but it is probable the beetles migrated from the boggy areas on the top of the mountain, directly behind this orchard.

Description of stages

The beetles (fig. 3) are brown, bronzed and shining with the margins of the wing covers greenish bronzed. The legs and antennae are reddish-yellow and the under surface of the body greenish. They are three-sixteenths of an inch, or slightly longer, and about one-half as wide. The following description of the adult is taken from Blatchley (3) and of the other stages from Scammell (10).

The Adult. — Oblong-oval, convex. Brown, bronzed, strongly shining, the elytral margins often greenish-bronzed; antennae and legs reddish-yellow, the outer joints of former often dusky; under surface of body greenish, abdomen brown, its tip paler. Head coarsely and sparsely punctate, clypeus more closely punctate. Thorax nearly twice as wide as long, narrowed in front, sides strongly curved, hind angles prominent; disk rather sparsely and finely punctate. Elytra coarsely but not closely punctate, the punctures irregular on the disk, a line representing the third interval smooth. Lenght 4-5 mm.

The Egg.—The eggs of the Cranberry Rootworm measure 0.67 mm. in length by 0.30 mm, in width. In shape they are regularly elongate, elliptical. When first deposited, they are dirty-white in color, later becoming uniformly yellow. The shell is smooth and glistening, and sufficiently transparent to reveal the larval outline before hatching.

The larva.—The full grown larva measures from 7-9 mm. Normally, it lies in a curved position so that its full length is seldom revealed. Its color is whitish with head light brown and thoracic shield of very pale yellowish-brown. Tips of mandibles black, shading off to light brown at the base. Labrum and clypeus brown. A row of brownish spines, the ambulatory setae, on each ventral abdominal segment projects obliquely backward. Setae long. Legs slender and small.

The Pupa.—The pupa is slightly shorter than the extended larva, whitish in color. Spines on the head and thorax are longer and stouter than those in the larval stage, The middle and posterior femora are each provided with one curved spine and two straight, more slender spines; two flattened hook-like spines, curving outward, are found at the posterior end of the abdomen.

Life history and habits

According to Scammell, the appearance of the beetles is dependent upon the withdrawal of the winter flood from the bog. When distrubed, they fly short distances seldom more than three or four feet. The eggs are found in clusters or singly ,but mostly the former, just below the surface of the soil usually. The egg period varies from 6 to 11 days. The larvae feed during the summer and late fall and commence to feed again in the spring soon after the water recedes. The larval period lasts ten months and some larvae may spend another year in the bog. The average duration of the pupal stage is 14½ days.

Control

Scammell (6) says an arsenical added to the customary Bordeaux and resin-fish oil soap is of value in killing the beetles on cranberry. Arsenate of lead, 1½ pounds to 50 gallons of water, has been recommended for cranberry but two applications should be made.

Franklin (8) states, after spraying cranberries with 2¼ pounds lead arsenate and 1½ teaspoondulls white arsenic to 40 gallons of water dead rootworm beetles were found in large numbers under the vines and only a few were crawling about.

Acording to Sawyer, (12) attemps to kill the beetles on apples by spraying with arsenate of lead were unsuccessful. Lead arsenate (powdered), 5 pounds, in 100 gallons summer strength lime-sulphur, was applied with great thoroughness without either killing the beetles or driving them away.

In a previous article, (13), I stated that the trees at Rougemont had been sprayed three times with Bordeaux mixture (4-4-40) and powdered lead arsenate, 1½ pounds to 40 gallons, before the infestation was examined on July 12. They were sprayed a fourth time on July 14 with the mixture just mentioned. The trees were examined five days later but the beetles were still present in large numbers. Apparently, the ordinary sprays are of little or no value in its control on apple. These sprays will have to be improved or other methods, devised, if the insect is to be controlled. Should this insect spread and establish itself in this province, it will cause very serious losses to our orchardists.

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TWO IMPORTANT INSECT ENEMIES OF THE MAPLE

By C. B. Hutchings

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The maple has been associated with Canada from the earliest of records. It thrives luxuriently in our forests and parks everywhere, and is planted more extensively in Eastern Canada for its shade, beauty and ornamentation than any other tree. The maple is not only one of the best Canadian hardwoods in point of importance, but its sap is used commercially in the manufacture of sugar and syrup, providing a substantial revenue of several million dollars annually, as the following figures will show:—

1924....	Sugar 9,385,415 lbs at 20.3c.....	$1,907,599
	Syrup 1,970,696 gals. at 20.72.....	4,083,542
		$5,991,141 *

To obtain these products it was necessary to tap over 22,600,000 trees. Besides its many enemies of fire, fungi, wind and animals there are no less than over one hundred insects which infest the maple. They attack different parts of the tree; some of these bore into the wood, some tunnel the bark, others girdle the twigs and destroy the leaves. Not infrequently the injury is severe enough to kill the tree. I am going now to refer, specially, to two species which are considered as very serious enemies:

1. The Sugar Maple Borer, *Glycobius speciosus* Say.
2. The Maple Leaf Cutter, *Paraclementia acerifoliella* Fitch.

The Sugar Maple Borer

The first mentioned may be said to be one of the worst insect enemies that attack the maple. The injury produced by it takes the form of girdling of the trunk which may bring about the death of the tree in some instances. During the past summer I visited a number of sugar maple bushes in Ontario and Quebec and without any exception the work of the borer was evident in every one. In some cases as high as 60% of the trees showed infestation; some of these trees were dead and others in a poor and dying condition.

Adult

The adult of the maple borer is a Cerambycid beetle about one inch long and of a particular striking appearance. The body is black with several decided bright yellow bands on the wing covers, one forming the letter W very distinctly.

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* Dom. Bur. of Statistics, Bull. Agr. Stat. Vol. 17, p. 244, 1924.

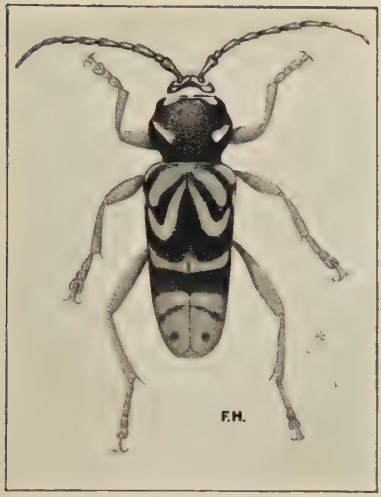


Fig. 1. -GLYCOBIUS SPECIOSUS Say adult enlarged about 1½ times. (Original).

Fig. 3.—PARACLEMENTIA ACERIFOLIELLA Fitch adult enlarged about 15 times. (Original).

Fig. 4.—Leaf of Sugar Maple showing work of Maple Leaf Cutter. (Original).

Fig. 2.—Maple Tree trunks injured by Sugar Maple Borer. On Left. Injury 10 ft up. Centre. Injury near base. Right. Bulging Scars, induced by larval work beneath. (Original).

Life-History and Injury

The beetle lays its eggs in the latter part of July and in August on the trunks of healthy trees. The young grubs work their way into the bark and spend the winter there. Next spring mining operations are carried on extensively in the bark in such a manner as often to completely girdle the tree. The bark above the tunnels becomes detached and drops off exposing the tunnel scars beneath. If complete girdling does not take place the tree will withstand the attack and heal the wound over with a thick callous; but where several larvæ are working together in the same area, the tunnels are apt to intersect and girdling will occur and the tree succumb. The mines very often measure over two feet in length and may be three-quarters of an inch wide at their further end.

Control

As to control, one of the best methods to be recommended is cutting out the very young larvæ before they get down into the bark. This has been tried with success. As the beetles are sun-loving, it is likely the cultivation of a heavy undergrowth will check them from laying, at least, on the lower parts of the trunk, which is a favourite place for deposition. At Ironsides, Que., a large sugar bush which I had the privilege of inspecting was covered with a heavy undergrowth and I attributed the low infestation of *Glycobius* (about 3 to 5%) as likely due to this factor, since no control measures whatever were practised.

The Maple Leaf Cutter

I should like now to refer for a few minutes to the Maple Leaf Cutter. As the name implies, it is a leaf feeder and its ravages while not as insidious as the Maple Borer's are much more apparent.

Last summer this insect was exceedingly abundant in Quebec and Ontario, large areas of maples were completely defoliated by it and some of the groves appeared as if fire had passed over them. Many inquiries were received at Ottawa and there was considerable apprehension among the farmers as to the effect the injury would be likely to have on their sugar output. From Kingston a report showed that 130 acres of maples had been defoliated by the Leaf Cutter. At Perth Road, a point on the C.N.R. about 80 miles west of Ottawa, which I visited, a wood lot of 300 acres was stripped bare, and all the maples from Perth Road as far east as Chaffey's Locks, a distance of 10 miles, were in like condition. It was in the Eastern Townships however, that the damage was most severe. At Belle Vallée in the Township of St. Johns, very close to the centre of the Gipsy Moth infestation, there was a particularly heavy outbreak. About two-thirds of the foliage was off the trees and the remainder was riddled and skeletonized so badly that not a vestige of green remained. The ground, stones, and different objects around were thickly covered with the small circular cases. All

the beech trees in the wood were badly attacked, and the elms also showed signs of slight infestation. At Frelighburg an entire hillside instead of being green was changed to a dull reddish brown and attracted attention even from a long distance. Observations were made at a number of towns and villages in the counties of Missisquoi, Huntingdon and Brome and there was scarcely a place the insect was not to be found in large numbers.

Former Records

The first Canadian record of the Maple Leaf Cutter was made in 1872 by Mr. E. Baynes Reed who reported it about London, Ont., as being "unusually noticeable." Dr. Fyles observed an outbreak in Missisquoi County, Que., near Sweetsburg in 1881. Dr. Fletcher, in 1885, recorded it as being severe in Ottawa and instanced four acres of maples near Government House Grounds which were completely defoliated by this pest. In 1887, Dr. Fletcher again referred to it as "continuing to increase to an alarming extent." The only other reference I could find was one by Dr. Hewitt, in his 3rd Annual Report on page 182, where he speaks of *P. acerifoliella* as being very prevalent during the summer of 1911.

Adult

The adult is a microlepidopteron of a third of an inch spread, the forewings being bright steel blue and the unders smoky brown. A tuft of yellow hairs on the head gives the moth quite a characteristic and distinctive marking.

Larva

The larva when full grown is a quarter of an inch long, flat, cylindric in outline, and dull white in colour. For the first ten days of its existence it works as a miner in the leaf tissues. It then cuts out an oval case from the mine, top and bottom, making the lower half a little larger than the upper. This done it comes to the exterior, turns the case upside down, anchors it with silken threads to the leaf surface and continues to feed from within the protecting covers. When the second covering is to be cut out, the larva projects its head for a short distance beyond the case and makes a narrow slit right around its circular house. The new circle which now supports the old case is prevented from dropping to the ground by the silk threads, and when these are severed the circle is dragged away out of the hole in the leaf, inverted, and secured to the old case to form a new roof. This is done again for the third time, after which the cases fall to the ground where the larvæ transform to yellow-brown pupæ. From these the moths emerge in swarms during the later part of May to lay their eggs on the underside of the leaves.

Control

A lead arsenate spray of the usual strength of 1½ lbs. of powder to 40 gallons of water will hold the larvæ in check, and should be applied in early summer for the best results.

Raking the leaves and rubbish into piles away from the trees and burning same, where this can be feasibly done, will act as a good control. Some farmers object to this method on the ground that their trees are often injured by the fire. However, if carefully carried out, burning should not damage the trees and it certainly will kill off enormous numbers of the pupæ. This work can be done best late in the fall, or sometime in spring during the last of April or very early in May. Two factors enter into leaf-burning operations, viz., humidity and wind. If the weather is damp it is a waste of time to attempt burning; on the other hand if too dry burning becomes dangerous. Morning hours are not good for starting a fire because the wind is apt to rise after the sun gets well up, whereas in the afternoon the maximum temperature of the day has been reached by 2 p. m. and the tendency then will be for the wind to fall again, making it easier to extinguish fires at night fall. The question of burning for the control of the Maple Leaf Cutter is to be taken up more thoroughly this coming summer; the results of which will be published in due course of time.

PHYSIOLOGICAL SPECIALIZATION OF COLLETOTRICHUM LINDEMUTHIANUM IN EASTERN CANADA.

By K. A. Harrison, B.S.A., M. Sc.

Introduction.

A general study was made during the past winter in the laboratory and greenhouses of the Dept. of Botany at Macdonald College of the organism causing a very common disease of beans, and the following article reports on the most interesting phase of the work. While beans cannot be classed as a major crop in Canada still they are important enough to be considered as a staple one and of greater proportional importance to Quebec than the rest of Canada. The acreage and yield of field beans, the only ones of which it has been possible to secure statistics, has been decreasing since the war. The following table illustrates certain of these facts clearly and was compiled from the Monthly Bulletin of Agricultural Statistics (4).

The Yields in Bushels and Value of the Bean Crop.

—	1918 bu.	1922 bu.	Average from 1917–21	Average price 1917–21.
Canada	3,563,380	1,303,300	1,716,236	$ 8,613,200
Quebec	1,867,000	505,500	944,480	5,056,180
New-Brunswick	85,580	64,000	59,106	329,360
Nova Scotia	143,000	59,000	78,290	502,460
P. E. I.	No statistics available.			

The disease under discussion, commonly called Anthracnose or Pod Spot of Beans, is the most serious disease that attacks them. It has been reported from as far north as Alaska, as far south as Australia, and has also been reported as occurring in the tropics, though it cannot be so serious there economically because of the fact that the disease thrives best in a temperature of 22.5 C. or 72.5 F. In the temperate zone, with a moderate climate and plenty of rainfall, the disease becomes the most frequent limiting factor that the farmer has to consider when planning his crop for the year. It attacks the bean plant in all stages of growth; it kills the seedlings after they start to develop; causes the leaves to drop by necrosis of the petioles on the more mature plants; spots the pods of both field and snap varieties; and disfigures the beans with brownish lesions and discolorations on the seedcoat. The disease is carried over winter in the beans themselves and it is spread in the field when moisture frees the spores so that they can be carried by some agency such as man, or splashed by falling rain drops.

Anthracnose of beans is caused by *Colletotrichum lindemuthianum* (Sacc. et Magn.) Bri. et. Cav. of the order Melanconiales of the Fungi Imperfecti. A perfect stage has been reported by Shear and Wood (8) as a Glomerella but it has not been generally accepted. The disease is of great interest to plant pathologists, not only because of its economic importance, but also because there are certain physiological species or forms within this species that have no morphological characters by which they may be distinguished but which have very different powers of infecting bean varieties.

The history of physiological specialization in *Colletotrichum lindemuthianum* dates back to 1911 when Barrus (1) made the announcement that he had discovered two strains of this pathogen by means of their ability to infect different varieties of beans. Since then several investigators have used this organism for a study of the number of physiological species present and their bearing in the breeding problem.

Barrus (2) continued his investigations and classified all the cultures that he had isolated. He found that they could be divided easily into two clear cut groups based on the infection results on the bean varieties used and designates them by the Greek letters *alpha* and *beta*. He also divided beans into

groups on their reactions to these strains; in the resistant group, he only found two varieties, Well's Red Kidney and White Imperial; a second group was resistant to *alpha* but not to *beta*; a third was resistant to *beta* but not to *alpha*; and the fourth was susceptible to both strains.

Edgerton and Moreland (5) in 1916 reported on the results of inoculations made with eight cultures and three reisolations from them, and considered from the infection results on the varieties used, that they had three strains of the pathogen One group was infectious on all but one variety used, viz: Large White Kidney, a second that infected Boston Pea heavily and Red Kidney lightly, and a third that infected Red Kidney severely but the Boston Pea lightly.

Burkholder (3) working in New York State reported on an isolation made from beans of the White Imperial variety that Barrus considered resistant; and found that he had a strain that was infectious on the White Imperial and which completely killed Well's Red Kidney, considered as the most resistant variety, in the seedling stage. He found, however, that the Michigan Robust which was resistant to the *beta* strain was also resistant to the new one. This strain was denoted by the Greek letter *gamma*. Burkholder considered that this new strain arose as a mutation from the *beta*.

The latest work was done by Leach (6) at Minnesota, who, as a result of inoculations made with fifteen cultures on sixteen varieties decides that he can distinguish eight physiological species and he set up a dichotomous key for tracing these species by a series of inoculations on seven varieties of beans. He attempted to find some other method of identifying these species but decided that the differences noted did not remain constant enough to use with certainty.

Experimental Work.

The present work has been largely along the lines of a study of the physiological specialization in *Colletotrichum lindemuthianum* in Eastern Canada, both as to the number of species present and the frequency of occurrence of any such species. Attempts were made to secure the perfect stage but they were unsuccessful.

The cultures used were largely collected from the Macdonald College farm from as wide a range of bean varieties as possible. Letters were also sent out to various places in Ontario, New Brunswick and Nova Scotia and samples of diseased pods and beans received. It was found impossible to isolate Colletotrichum from over one-half of these, due to the samples being heavily contaminated with secondary organisms before being received. A number of lesions not unlike anthracnose were noticed on Soy beans growing in the same patch with garden beans, but all attempts to isolate *C. lindemuthianum* failed. It is of interest to note that a bean pod from Nova Scotia, apparently infected with anthracnose of a very severe type only gave rise on culturing to *Phyllosticta phaseolina* Sacc. It was similar macroscopically in culture, and on the seedlings

the infection was so nearly identical that the first stages of Phyllosticta and *C. lindemuthianum* could not be told apart.

In addition to the cultures isolated here, Dr. B. T. Dickson supplied Barrus' *alpha* and *beta* strains and an isolation made from Quebec material. These were not in a sporulating condition and as it was found impossible to rejuvenate them, they were not used in any of the infection experiments.

Dr. J. G. Leach kindly supplied six of his cultures, one of which did not sporulate consistently and was not used for that reason in the infection experiments. The following in a list, with all the available information, of the cultures and their sources.

Cultures and their Sources.

Culture.

Alpha: Obtained from Dr. Dickson, who had received it from Dr. M. F. Barrus of Cornell University. It had been in culture for some time.

Beta: Obtained from Dr. Dickson, who had received it from Dr. M. F. Barrus of Cornell University. It has been in culture for some time.

Quebec Strain: Obtained from Dr. Dickson, who had isolated it from Quebec material. It had been in culture for some time.

Leach's Forms I, II, III, IV, and VIII were all supplied by him from cultures used in his work (6).

1. Isolated by H. R. Angell, Oct. 1st. from a bean from a private garden in Ste. Anne de Bellevue.
2. Isolated from a black kidney bean from the Horticultural Department's plots.
4. Isolated from a wax podded bean that was not seriouslv infected, Horticultural Department.
5. Isolated from a green podded type that was not seriously infected, Horticultural Department.
6. Isolated from a yellow wax-podded bean, Horticultural Department.
16. Isolated from a pod of Perry's Special, School plots on the College farm.
23. Isolated from bean seeds that Dr. Dickson had secured from the Horticultural Department. (Very heavily infected.)
25. Isolated from a wax podded bean showing very large lesions, Horticultural Department.
26. Isolated from a bean pod sent in from Maugerville, N. B. Unknown variety.
29. Isolated from a bean pod sent by Dr. M. F. Barrus, Cornell University. An unknown variety and very seriously infected.
30. Isolated from a bean pod sent by Dr. R. E. Stone, Guelph, Ont. Bean No. 7251.
31. Isolated from a bean sent by Dr. R. E. Stone, Guelph, Ont. Bean .5022.

32. Isolated from a bean pod sent by Dr. R. E. Stone, Guelph, Ont. Bean No. 7521. Early brown.
33. Isolated from a bean pod sent in by Dr. R. E. Stone, Guelph, Ont. Bean No. 7621. Brown.
35. Isolated from a wax podded black kidney type secured from Maugerville, N. B.
36. Isolated from a green podded type purchased by Dr. B. T. Dickson in the Ste. Anne de Bellevue market in April, 1925.

All the cultures not specifically mentioned were isolated in October and early November of 1924.

The beans for the inoculation experiments were secured from several places. Dr. J. G. Leach was kind enough to send the varieties that he names in his bulletin for his key.

The cereal Division of the Central Experimental Farm, Ottawa, supplied seven varieties grown there.

The largest number were secured by the kindness of H. M. Racicot, who supplied the varieties being tested at Ste. Anne de la Pocatière Experimental Station. The following is a list of all the varieties received.

List of Varieties of Beans and Sources.

From J. G. Leach, Minnesota.

Brown Swedish, Minn. 132.
Navy, Minn. 69.
Red Kidney, Minn. 156.
Red Indian, Minn. 1101.
Navy, Minn. 1083.
Ruby Horticultural Bush, Minn. 98.
Improved Yellow Eye, Minn. 1096.

From Central Experimental Farm, Ottawa.

Golden Wax Selected.
Yellow Eye.
Robust Navy.
Navy, O.711
Robust.
Large White, O.713.
Well's Red Kidney.

From Ste Anne de la Pocatiere.

No.	Reaction to culture 1.
1. Wardwell's Kidney Wax.	S
2. Davis' Kidney Wax.	CS.
3. Well's Kidney Wax	R
4. Black Seed Wax Prolific.	S
5. Prolific Black Wax.	CS.
6.. Black Seeded Wax	CS.
7. Early Black or Butter Wax.	S
8. Improved Golden Wax.	CS.

No.		Reaction to culture 1
9.	Golden Podded Wax.	CS.
10.	Michigan White Wax.	CS.
11.	Davis' White Wax.	VR.
12.	Round Pod Wax.	CS.
13.	Detroit Wax (D. M. Ferry)	CS.
14.	Hudson Wax.	CS.
15.	Wax Chief.	S
16.	Stringless Refugee Wax.	CS.
17.	Valentine Wax.	CS.
18.	Yosemite Wax.	CS.
19.	Giant Stringless Green Pod.	SS.
20.	Ely Stringless Green Pod.	CS.
21.	Stringless Green Pod.	CS.
22.	New White Selected Green Pod.	VR.
23.	Bountiful Green Pod.	S.
24.	Davis' Green Pod.	R.
25.	Green Pod Refugee.	S.
26.	Yellow Eye.	CS.
27.	Improved Yellow Eye.	SR.
28.	Yellow Eye, Mammoth Me. 1317.	S
29.	Yellow Eye, Mammoth Me. 1377.	S
30.	Yellow Six Weeks (short strain)	S
31.	Yellow Six Weeks'	VR.
32.	Early Yellow Kidney Six Weeks.	CS.
33.	Early Yellow or Six Weeks.	CS.
34.	Chinese Bush.	CS.
35.	White Bush Bean (vary)	
36.	Early Valentine or Podded.	CS.
37.	Early Red Valentine.	CS.
38.	Extra Early Red Valentine.	CS.
39.	Mohawk.	CS.
40.	Early Mohawk.	CS.
41.	Horticultural Dwarf.	CS.
42.	Dewarf French Excelsior.	S.
43.	Refugee or 1000 to 1.	CS.
44.	Extra Early Refugee.	CS.
45.	White Pea Bean.	VR.
46.	Marrowfoot (George Saunders)	CS.
47.	White Navy.	VR.
48.	Soldier Bean.	S.
49.	Fordhook Favorite.	VR.
50.	California Wonder	VR.
51.	French Lima.	CS.
52.	May Queen	S.
53.	Honey Pod.	CS.
54.	Cornell Rustless.	S.
55.	Veitch Hybrid.	
56.	William, Earliest of All.	CS.
57.	Long Pod Forcer.	C.S
58.	Selected Canadian Wonder	VR.
59.	Early China	S
60.	Sure Crop Stringless.	CS.

No.		Reaction to culture 1.
61.	Full Measure Bushel.	CS.
62.	Mighty Nice.	CS.
63.	Plentiful French.	CS.
64.	Non Pareil.	S.
65.	Ne Plus Ultra.	CS.

Inoculation Experiments.

After a few preliminary lots of beans had been inoculated to study the conditions necessary for infection, culture No. 1 was used to inoculate the varieties of beans received from Ste. Anne de la Pocatière and from these results, which are given with the list of vaieties, sixteen were selected largely on account of their showing resistance or types of resistance. One completely susceptible and three susceptible were included, the aim being to get a variety of reactions to the various cultures and at the same time test out those resistant as far as the time available allowed. All the cultures sporulating at the time of making the inoculations were used on the sixteen varieties.

The beans were grown in pots in the greenhouse on benches and were inoculated as soon as the first pair of true leaves had spread out. Such early inoculation was to eliminate any danger of differences of resistance from the ageing of the tissues. This plan made it necessary to inoculate on different days; 48 hours being the longest apart of the inoculations on any one variety.

In addition to the age of the tissue as a factor in resistance it was later found that ordinary fluctuations in weather conditions produced an error just as great, though more easily determined.

Inoculations were made by carefully spraying all parts of the seedlings with a turbid suspension of spores with an atomizer. All spore suspensions were made equally turbid and the atomizers were sterlized, after each culture used, in 60 per cent alcohol for at least five minutes.

The plants were placed in a moist chamber after inoculating and kept in a greenhouse normally run at 70 F. At the end of 48 hours they were removed and placed on benches and observations made each day, until the tenth after inoculation when the final records on the degree of infection were taken.

Signs of infection were usually easily seen on the sixth day though it ranged from early on the fifth to the seventh. In some cases of extreme susceptibility, the plants had completely wilted and fallen over on the sixth day. This condition was peculiar as there were no signs of the typical brown lesions; just water soaked areas being present on the stem on which, in a day or two, acervuli, producing-spores, showed as brown flecks. This early wilting and dying must not be confused with the wilting that was so often evident when the plants were first taken from the humid atmosphere of the moist chamber. This latter condition was never present after the first 24 hours and the plants appeared perfectly healthy until the sixth or seventh day when they again wilted and died completely if they were a susceptible variety.

For convenience in taking records letters were used indicating the degree

of infection evident upon the seedling. Five classes were made taking in as far as possible an equal range of infection. Fig. 1 illustrates this.

VR stands for "very resistant" and the plants only show a reddish flecking.

R stands for "resistant" and the plants show small lesions that do not develop into typical anthracnose spots.

SR stands for "slightly resistant". The plants show many small lesions that do not develop but with them are lesions that interfere to a slight degree with the growth of the plant. This division includes the doubtful cases of resistance and susceptibility and according to observations a difference in environmental factors might easily place these into either the resistant or susceptible groups.

S stands for "susceptible". The plants produce typical lesions that develop acervuli and spores by the time the records are taken.

CS stands for "completely susceptible". The plant is dead or so nearly so that it will not recover.

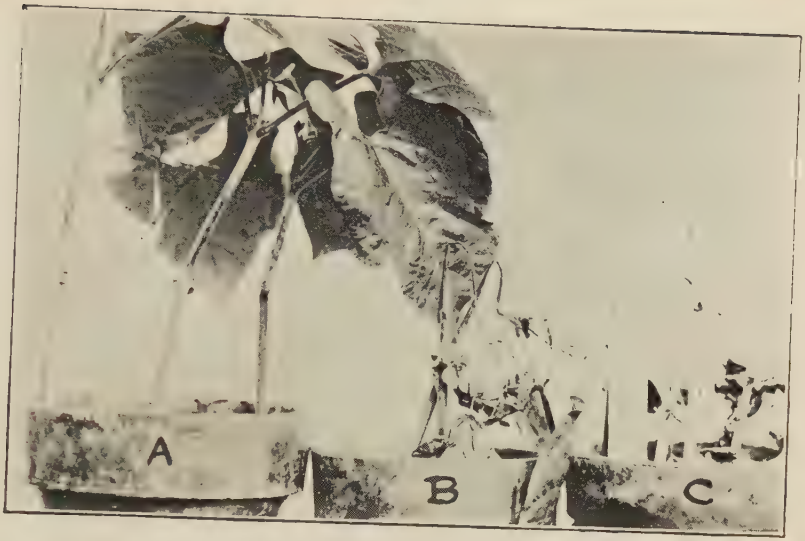
The taking of records was often rendered difficult by reason of the different effects on bean varieties as for example on pea and wax beans.

Discussion of Tables.

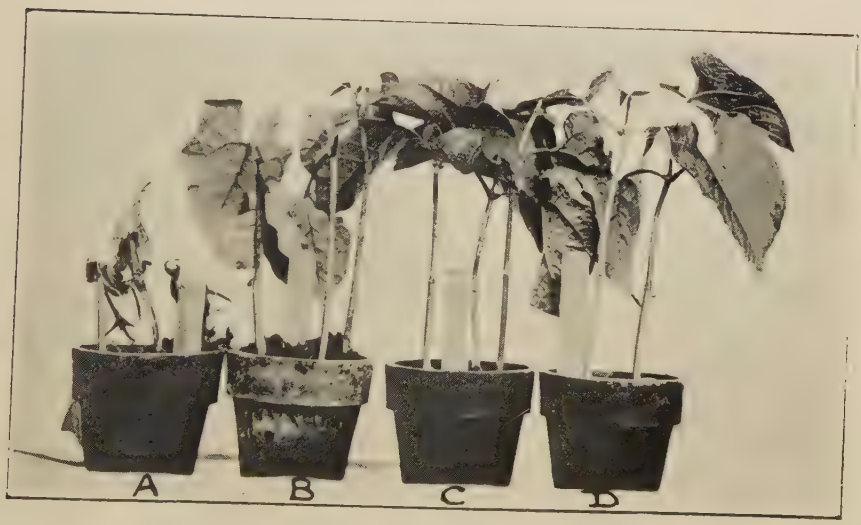
The following table shows the reactions of all the cultures isolated during the work on thirteen varieties of beans. Three other varieties, Well's Kidney Wax, Selected Canadian Wonder, and Dwarf French Excelsior, were also used in this experiment, but a few beans were found in each that gave such a different type of infection that they were left out. These varieties were therefore not considered as being pure line strains and possibly they did not constitute a pure variety.

A study of Table II shows five varieties that gave a uniform reaction to all the cultures; Well's Red Kidney is one of these; the difference noted being attributed to a change in weather conditions as one part was inoculated on a fine day and the rest on a rainy. In considering the remaining eight varieties, it is noticed that the majority of the cultures give nearly identical results on the bean varieties. Cultures, 2, 4, 5, 26 and 31 are identical in their infection capacities, 6, 25 and 29 vary but little from them, and 1, 30 and 32 vary a little more widely but only on the White Pea Bean which was the first to be inoculated. It is quite possible that errors might have crept in that would explain any such minor differences, especially so in this case for it has already been pointed out that with pea beans it is often difficult to be certain of the degree of infection. Culture 33 varies more widely still and is resisted by a variety that was completely susceptible to all the other cultures and is infectious on a variety that constantly shows varying degrees of resistance to other strains.

The remaining four cultures vary quite markedly. Yellow Six Weeks is completely susceptible to culture 36 and this is a variety that is very resistant to all of the other cultures. Culture 36 also shows a slight difference on large White, 0-713 and on this variety gives a similar reaction to 16 and 35. Cul-

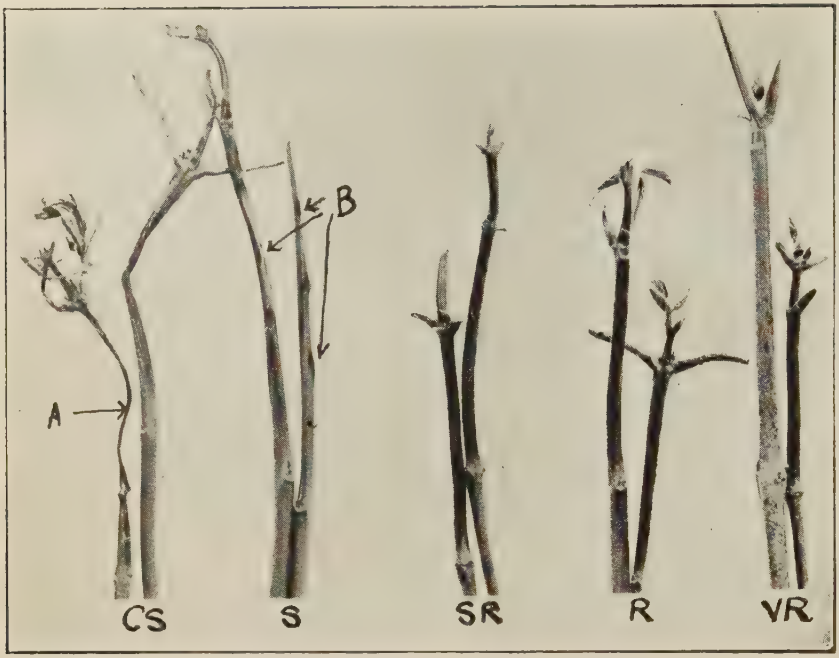


Nonpareil inoculated with
A—Culture 23
B— " 2
C— " 5



Improved Yellow Eye
A—Culture 31
B— " 29
C— " 23
D— " IV

PLATE VI.



Bean stems from plants showing gradation from complete susceptibility to complete resistance.

Bean leaflets showing typical lesions at A.

TABLE II

Infection obatined with sixteen cultures on thirteen varieties of beans.

VARIETY INOCULATED	CULTURE NUMBERS															
	1	2	4	5	6	16	23	25	26	29	30	31	32	33	35	36
Wardwell's Kidney Wax	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
Davis' White Wax	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	
New White Selected Green Pod	VR	VR	VR	R	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	CS	
Davis' Green Pod	SR	SR	SR	SR		VR	VR		SR	SR	SR	SR	SR	S	SR	
Improved Yellow Eye	CS	CS	CS	CS	CS	CS	SR	S	CS	S	CS	CS	CS	CS	CS	
Yellow Six Weeks	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	CS	
White Pea Bean	S	SR	SR	SR	R		SR	SR	SR	R	S	SR	S	SR		
Marrowfat	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	R	CS	
Fordhook Favorite	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR		
Non Pareil	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	
Large White, 0.713	CS	CS	CS	CS	CS	S	CS	CS	CS	CS	CS	CS	S	S	S	
Robust	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	VR	
Well's Red Kidney	R	VR	VR	VR	VR	VR	VR	VR	VR	VR	R	R	R	R	R	

tures 16 and 35 differ on two varieties and 23 on three. It might be a matter of doubt in the case of a very resistant variety if error had not crept in and interfered with infection. This, however, did not seem possible for in some cases more than one variety was inoculated and one would show typical lesions and the other would have to be classed as very resistant.

Table III shows five of Leach's Forms and their infection capacities on the same thirteen varieties used in Table II.

TABLE III

Infection obtained with five of Leach's cultures on thirteen varieties of beans.

VARIETIES INOCULATED	LEACH'S FORM				
	I	II	III	IV	VIII
Wardwell's Kidney Wax	CS	CS	CS	S	S
Davis' White Wax	VR	VR	VR	CS	
New White Selected Green Pod	VR	VR	VR	CS	VR
Davis' Green Pod	SR	SR	S	CS	VR
Improved Yellow Eye	CS	CS	S	VR	
Yellow Six Weeks	VR	VR	VR	CS	VR
White Pea Bean	S	S	S	CS	S
Marrow Fat	CS	CS	CS	CS	R
Fordhook Favorite	VR	VR	VR	CS	
Non Pareil	CS	CS	CS	CS	CS
Large White 0.713	CS	CS	CS	S	S
Robust	VR	VR	VR	CS	VR
Well's Red Kidney	R	R	R	VR	R

Forms I and II are identical in their infection capacities on the varieties in Table III, and Form III differs slightly on two varieties only, with VIII differing on three. Form IV is strikingly different indeed, as practically every variety is susceptible to it. The only two varieties resistant to this culture are Well's Red Kidney and Improved Yellow Eye.

Table IV shows the degree of infection obtained on Leach's differential hosts. The beans were all planted the same afternoon and the seedlings were were inoculated at the same time under uniform conditions.

TABLE IV

Infection obtained on Leachs' differential hosts with fifteen culture.

VARIETY INOCULATED	Form. Culture No.	I					II					VIII				
		4	6	31	32	33	2	5	25	26	35	1	16	29	30	23
Brown Swedish	Minn. 132	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
Navy	Minn 69	SR	SR	CS	SR	CS	SR	S	CS	CS	SR	R	R	VR	VR	R
Red Kidney	Minn. 156	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
Red Indian	Minn. 1101	CS	S	CS	CS	CS	R	R	R	R	R	R	R	R	S	R
Navy	Minn. 1083	VR	R	VR	VR	VR	VR	R	VR	VR	VR	CS	CS	CS	CS	CS
Ruby Hort. Bush	Minn. 98	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
Improved Yellow Eye	Minn. 1096	CS	S	CS	CS	CS	CS	CS	CS	CS	CS	S	CS	SR	CS	VR

Of the seven varieties inoculated, three showed extreme susceptibility to all of the cultures used, and one was uniformly resistant. Red Indian, Minn. 1101 which is used to separate Form I gave a very peculiar reaction to the various cultures. Those marked CS were very badly infected and died, but the lesions were not typical of the usual CS type of infection. They were superficial in appearance and did not kill so quickly.

Leach's dichotomous key (6) was used to separate the various cultures into the following groups: Form I:—4, 6, 31, 32, and 33. Form II:—2, 5, 25, 26, and 35. Form VIII: –1, 16, 29, and 30. Culture 23 also comes in Form VIII but Improved Yellow Eye, Minn. 1096 is very resistant to it. Apparantly it does not fit in with Form VII for Ruby Horticultural Bush, Minn. 98 is completely susceptible.

A close inspection of these three groups, made by using the key, shows that they can still be split into other groups. Thus under Form I we have 31 and 33 similar, and 4, 6, and 32 forming another set. Under Form II, 2 and 35 go together, while 5, 25, 26 constitute a group with similar reactions. Form VIII is not so clear but 16 and 30 are closely similar while 1 and 29 are individuals.

A comparison of all three infection tables would seem to show the following facts:—It is impossible to distinguish I and II from the majority of the cultures isolated here during the course of the work, on the Quebec varieties of beans

used. Form III differs so little that it is a matter of doubt if it could be positively determined, but VIII gave differences that showed in the tables. The differences observed with Leach's Form VIII are not shown, however, by the group that comes under it when using his differential hosts. The recently isolated culture 36 caused infection similar to that obtained with IV. This was also observed on Well's Kidney Wax, which was not included because of four plants that were susceptible when all the rest were resistant, excepting in the case of Form IV, and culture 36, where all the plants were susceptible.

A Group Separated by Cultural Characteristicts.

Constant watch was kept from the first for any differences in the cultures on the various media used to see if it were possible to identify the various cultures or forms from one another and if any such differences did appear to see if they confirmed the differences in infection results. Leach's Forms when first transferred to potato dextrose agar gave quite noticeable variations but these gradually disappeared in all cases but IV, and V, V being easily identified by a whitish colony and very poor sporulation. There appears to be a constant relationship between a whitish colony and poor sporulation. The distingishing characters of IV remained constant on potato agar and were identical with cultures 16 and 35. These cultures on slants of potato dextrose agar were slower growing; had a tendency to lobing at the edge and formed a thick stroma-like mat of mycelum that developed very few spores and which as the colony aged took on a very characteristic wrinkled appearance. The slow growth and lobing of the margin was very evident in plate cultures but the stoma-like mat of mycelium and wrinkled surface seldom showed. It is interesting to note that the recently isolated culture 36 is showing a tendency to lobing at the margin of the colony and is a very slow grower. No differences in spore sizes were found.

A comparison of Cultures on Different Sources of Carbon.

The only work done on this that has been noted was by Leach (6). He obtained such marked differences with mannitol that all cultures on hand at the time were grown on a modified Czapeck's solution with it as the carbon source.

The solution used is as follows:—0.5 gm. magnesium sulphate, 1.0 gm. monobasic potassium phosphate, 0.5 gm. potassium chloride, 0.01 gm. ferrous sulphate, 2.0 gm. sodium nitrate and 30.0 gm. of cane sugar in one litre of distilled water. This solution was made up without the sugar, and the salts for 1000 cc. were mixed with 900 cc. of water. 45 cc. of this solution was placed in each flask which were two sizes, one holding 200 cc. and a check that held 150 cc. These were plugged and autoclaved at 17 lbs. pressure for twenty minutes. After they had cooled, 5 cc. of an 8 per cent solution of the carbon source was added, which made the concentration of the sugar in the culture 0.8 per cent. The carbon source was first sterilized by using a Chamberland filter. The flasks were inoculated by washing off all the spores that could be picked up in a

sterile loop. In cases where spores were not being produced in the four cultures that would not sporulate, a small portion of mycelium was transferred. The cultures were allowed to grow for forty days in a temperature held between 22° and 24° C. The weights of dried mycelium are given in Table V.

When the cultures were split up according to Leach's differential hosts, it was seen that the cultures that came under:—

Form I gave an average weight of .0157 gm.
Form II " " " " " .0088 "
Form VIII " " " " " .0096 "

While Leach's Form I gave an average for two flasks of .0625
" Form II " " " " " " .112
" Form VIII " " " " " " .0125

There does not seem to be any possible correlation between them, but when the weights are taken of the groupings that apeared as a result of the infections that are shown in Table II, it is possible to see a certain amount of uniformity. Cultures 2, 4, 5, 26 and 31 that are identical in Table II give an average weight

TABLE V

Growth weights on modified Czapeck's Solution with Mannitol as the Carbon Source.

CULTURE	Dry Weight of Mycelium in Grams			
	Flask 1.	Flask 2.	Total	Average
Alpha	.....	.046	.046	.046
Beta	.084	.100	.184	.092
Quebec Straim	.065	.046	.111	.0555
1	.095	0.30	.125	.0625
II	.....	.112	.112	.112
III	.012	.007	.019	.0095
IV	.003	.000	.003	.0015
V	.018	.014	.032	.016
VIII	.012	.013	.025	.0125
1	.008	.005	.013	.0065
2	.007	.005	.012	.006
4	0.07	.013	.020	.010
5	.011	.005	.016	.008
6	.035	.008	.043	.0215
16	Very slight growth.			
23	.007	.013	.020	.010
25	.025	.017	.042	.021
26	.010	.007	.017	.0085
29	.030	.011	.041	.0205
30	.012	.010	.022	.011
31	.009	.....	.009	.009
32	.011	.014	.025	.0125
33	.042	.009	.051	.0255
35	.001	.....	.001	.0005

of .0083 of a gram, F .0023, cultures 1, 30, and 32 have an average weight of .01, F .0035, and cultures 6,25, and 29 are .021, F .0005 in average weight. Culture 33 which is .0255 is similar in weight to these last but differs somewhat in

nfection. Culture 23 which has an average weight of .01 agrees with the second group but has different infection capacities as shown by Tables II and IV. Culture 16 and 25 are outstanding in the very small amount of growth and agree with IV on this media as they did on potato dextrose agar.

Taking these results it is possible to divide the cultures into the following three groups:—

I. 2, 4, 5, 26, 31; 1, 30, 32 and possibly 23.
II. 6, 25, 29 and 33.
III. 16 and 35.

Table IV shows the weights obtained in a test with four cultures on four carbon sources. A fifth source of carbon was used but only gave a trace of growth. Four of the most interesting of the cultures were selected for this test which, however, was only allowed to run four weeks on account of the time avai-'able.

TABLE VI

Selected cultures growth on Czapeck's solution modified in carbon source.

CULTURE	Dry Weight of Mycelium in Grams				Carbon source.
	Flask 1.	Flask 2.	Total	Average	
16*	.005	.....	.005	.0025	Maltose.
2	.113	.....	.113	.13	"
23	.142	.152	.294	.147	"
35*	No weight	evident.	Slight growth		"
16*	.006	.....	.006	.003	Aspagarin.
2	.040	.024	.064	.032	"
23	.023	.023	.046	.023	"
35*	.006	.....	.006	.003	"
16*	.015	.....	.015	.0075	Dextrin.
2	.058	.060	.118	.059	"
23	.....	.065	.065	.065	"
35*	.020	.....	.020	.010	"
16*	.007	.....	.007	.0045	Dextrose.
2	.107	.115	.222	.111	"
23	.090	.117	.207	.1035	"
35*	No weight	evident.	Slight growth		

* Growth so slight that both were put together to get the weight.

Cellulose acetate was also tested but the growth was so slight that it could not be weighed.

Again the most striking fact is the very low weights of mycelium obtained from cultures 16 and 35, on all the carbon sources. Cultures 2 and 23 give appreciable differences in average weight on maltose and asparagin.

Testing the Nutrient Requirements by Triangulation.

It was hoped that interesting variations might appear if the nutrient requirements were worked out after the method of Young and Bennet (9) and used in 1923 by Scott (8) in working out the relationships of a group of cultures to prove that they were all one Collectotrichum. A series of twenty-one cultures, using potassium acid phosphate (monobasic), calcium nitrate and magnesium sulphate were set up. The salts varied in the different solutions by increments of one-eighth and had an osmotic concentration of three and one-half atmospheres. Sucrose was added in equal amounts 3.42 grams per 100 c.c. of the culture, thereby giving the culture solution a total osmotic pressure of four ad one-half atmospheres.

In these triangles the individual cultures are numbered according to the row in which they occur and according to their position in the row. The rows are numbered from the base to the apex of the triangle. The position in the row is from left to right. Thus the culture on the extreme left of the first row is numbered 11, the second from the left in the third is 32, and in this way every culture received a number.

The method of arranging the concentrations is given in the following table.

TABLE VII

Showing the amounts to use in making up the flasks for the triangulation experiment.

Flask No.	cc. of M/14 KH2 PO4	cc. of M/14 Ca (No3) 2	cc. of M/14 MgSO4	cc. of sugar sol. 3.42 gm in 10 cc.	Water to make sol. to 50 cc.
11	4.0	4.0	22.4	5	14.6
22	3.5	6.8	17.2	5	17.5
13	34.	10.0	13.2	5	18.4
14	3.1	12.4	9.4	5	20.1
15	3.1	15.0	6.0	5	20.9
16	3.0	17.0	2.8	5	22.2
21	7.4	4.0	17.2	5	16.4
22	7.0	6.8	13.2	5	18.0
23	6.5	10.0	9.4	5	19.6
24	6.2	12.4	6.0	5	20.4
25	6.0	15.0	2.8	5	21.2
31	10.6	4.0	13.2	5	17.2
32	10.0	6.8	9.4	5	18.8
33	9.5	10.0	6.0	5	19.5
34	9.0	12.4	2.8	5	20.8
41	13.8	4.0	9.4	5	17.8
42	13.2	6.8	6.0	5	19.0
43	12.6	10.0	2.8	5	19.6
51	17.2	4.0	6.0	5	17.8
52	16.4	6.8	2.8	5	19.0
61	20.3	4.0	2.8	5	17.9

The flasks containing the media were autoclaved at seventeen pounds pressure for twenty minutes and after cooling were inocu ated ith 1cc. of a turbid spore suspension. The cultures were allowed to grow for four weeks under the same conditions as the other growth experiments, and the results are given in Table VIII.

TABLE VIII

Triangulation to determine the nutrient requirements.

Culture No.23 (weights in gms.)

Culture No. 16.

Again the most noticeable feature is the very slight growth made by 16. Culture 23 gave excellent growth and on many of the flasks a mycelial mat that produced spores was formed on the surface of the solution.

In making a contour that surrounds the cultures giving the largest amounts of mycelium in each triangle, it is noticed that one appears as though it could be fitted into the other almost like a key into a lock.

The identity of the cultures isolated.

These have already been compared with those from Leach's work. In comparing them with the results obtained by Barrus and Burkholder, it does not appear that Burkholder's *gamma* strain has been isolated so far as the present work goes. Barrus reports pea beans as resistant to the *beta* strain and Burkholder that the Robust variety is also. In the inoculation experiments White Pea Bean and Robust were resistant to the Canadian cultures used. It was noted that Barrus and Edgerton both reported the Davis, a wax podded bean as susceptible to all strains. Davis' White Wax here seems to be very resistant to all but IV. It cannot, however, be definitely stated that the two varieties are the same.

An attempt to secure the perfect stage.

This was a test to see if possibly there were plus and minus strains of the organism. All the cultures were used in this attempt so that the mycelium of every culture would mingle with mycelium from every other. A full test was made on potato dextrose agar and a few selected ones on cornmeal, oat decoction green bean and Czapeck's synthetic agars, but in all cases negative results were obtained.

Summary and conclusions.

1. A total of twenty-one cultures was used in a series of inoculation experiments on sixteen varieties of beans, results being given from thirteen as the other three were considered consisting of more than one pure line strain. These varieties were selected as a result of a preliminary test with sixty-five varieties inoculated with culture No. I.

2. Fifteen cultures isolated in the work were used to inoculate the seven varieties that Leach has used as differential hosts and using his dichotomous table they fall within Forms I, II, VIII, but considering the results as a whole these groupings are not uniform. The amount of seed for this experiment was limited and further work is almost certain to modify some of the discrepancies.

3. Culture 36 (probably from Florida) is considered as a separate strain and identical with IV and by comparing its reactions with those of Barrus' cultures it is considered as belonging to his *alpha* strain. All of the other cultures isolated during the course of the work are considered as coming under his *beta* strain. Some of the cultures show differences, but it is quite possible that

under slightly different conditions at the time of inoculation that these would come definitely under the *beta* strain.

4. A significant fact is that the *alpha* strain was not isolated out of fourteen cultures from Canadian material. It is known to be present, however, as varieties used here, known to be resistant to the *beta* and susceptible to the *alpha* have been reported as susceptible at the Experimental Stations where they have been tested.

5. Culture 23 gave the widest range of those worked with but not wide enough to take it out of the *beta* strain. It also differs widely from Form VIII when using Leach's key. In testing 23 on carbon sources it is found to differ from 2, a typical culture of the class to which the Canadian isolations are considered to belong, on maltose and aspâragin.

6. The only variety found resistant to all the cultures used was Well's Red Kidney. The varieties that proved resistant to the cultures from Canadian sources were Navy, Minn. 73, Davis' White Wax, Yellow Six Weeks, Robust and Fordkook Favorite (the latter not tested with culture 35). The last four varieties are from Quebec and were susceptible to Leach's Form IV.

7. Differences were noted on potato dextrose agar that remained constant and made it possible to identify cultures 16, 35 and IV whenever grown on that substratum. A study of these cultures in all the physiological experiments show that they are constantly associated wherever tested. Cultures 16, 35 and IV were not similar, however, in infection capacities on the varieties of beans inoculated.

8. A comparison of the infection results of the cultures isolated during the course of the work with their growth weights on mannitol shows that cultures grouped from slight differences in infection also gave different average weights.

9. The triangulation experiment brings out the differences between cultures 16 and 23 very markedly as the growth contours will partially fit into each other like a lock and key.

10. An attempt was made to secure the perfect stage from any of the isolations by growing several cultures in one plate so that the colonies would run together. No sign of a perfect stage was evident.

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PRELIMINARY REPORT ON A DISEASE OF COMMON BEAN

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Introduction

During the fall of 1924 while engaged in isolating cultures for a study of the physiological specialization in *Colletotrichum lindemuthianum* an organism was secured from a bean pod which later was considered as being identical with or very closely approximating the organism that is described as *Phyllosticta phaseolina* Sacc.

A search of the available literature has not given a very full description of the organism and disease and but very little as to its range. Martin (1) reports it as occurring on *Phaseolus diversifolius* in 1886. Farlow (2) in 1888 in his host ndex records that it is on the same host and also on *Phaseolus vulgaris*. Kellerman collected it in Ohio in 1901 on *Stylosanthes biflora* (L.) B.P.S. Harter (3) in an article on pod blight of lima beans caused by *Phoma subcircianata* E. & E. states that the two diseases may be confused and states that the following reports have been made; New Hersey (Ellis), Canada (Dearness) on *Phaseolus perennis*, Missouri (Galloway) and on cowpea, Kansas (D.B. Swingle). Coons (4) in 1916 reported a leaf spot on *Phaseolus vulgaris* which caused some anxiety to the growers in Michigan and states that it was due to a cowpea disease caused by *Phyllosticta phaseoli*. Cook (5) in a circular on diseases of peas and beans makes no reference to this organism when discussing "Pod Blight and Leaf Spot of Lima Beans (*Diaporthe phaseolarum*)", but states that "The disease on the pods and on the leaves was originally supposed to be two distinct diseases".

Harter, however, in his article on *Diaporthe phaseolarum* states very definitely that there are two diseases, one a leaf spot and the other a pod blight.

Apparently the original and only work on the pathogenicity of this organism was done by C. O. Smith (6), who was certain that he had the Phyllos-

ticta reported by Saccardo and considered that he did not have *Phoma subcircinata* E. & E. reported in 1892 and worked on by Halstead, as he states that the descriptions do not fit. In his inoculation experiments he used and infected wax and kidney beans, lima beans and cowpeas, and states that infection is entirely confined to the leaves. Smith's article seems to be the only one that gives a description of the organism and is not as full as one might wish so a brief study of the organism isolated was made.

History of culture.

Last autumn requests were sent out for bean pods affected with anthracnose and amongst other samples, one was received from a friend in Central Clarence, Annapolis Country, N.S., who was not familiar with diseases of plants in general. The sample was accompanied by a statement to the effect that it had been difficult, to secure spotted pods as there was very little disease on any of the beans. On opening the sample a large number of pods were found with very tiny flecks, but amongst them was a pod that had very large lesions which appeared identical with those produced by *Colletotrichum lindemuthianum*, excepting in the matter of size. Pieces of this severely affected pod were planted in plates of potato dextrose agar but the only result was an organism that developed rapidly and had a whitish superficial type of growth. This was set on one side in the hopes that later it would be possible to identify it. Spores were not in evidence until after Christmas when what looked like pinkish rhizomorphs were noticed penetrating into the substratum from the lower surface on the mycelial mat. These on investigation proved to be masses of spores less than half the size of those of *C. lindemuthianum*. A spore suspension was made in sterile water and diluted until it was estimated that 2cc. would contain about 25 spores and this amount was poured on the surface of plates of potato dextrose agar. The resulting colonies were different from the original but all had the same appearance and macroscopically were of the general Colletotrichum type. Transfers were made to agar slants and the organism studied in pure culture, the cultures being carried under identical conditions with those of *C. lindemuthianum*.

The organism.

Upon examination the main characters of this organism were found to come fairly close to Saccardo's description of *Phyllosticta phaseolina* Sacc. which is as follows; "Maculis amplis, vagis arescendo ochraceis; peritheciis sparsis, lenticularibus, 70 u diam. pertusis; sporulis ovoideo-oblongis, 6 by 2.5, rectis, rarius inæquilateralibus, hyalinis". Smith gave the description of the organism that he works with as follows; "Spots irregularly scattered, subcircular, 2-10 mm. in diameter, deep rusty brown, becoming lighter in the centre, and margin darker. Perithecia scattered, lenticular, 70-90 microns in diameter, sporules ovoid oblong, mostly straight, 4-6 x 2-2.5 microns. On leaves of

various Phaseoli." He then goes on to state that while Halsted illustrates leaf spots from the organism that he worked with, at the same time as spots on the pods, he (Smith) had not been able to get infection on the pods with his own organism. In looking up Halsted's pictures of "Pod blight of lima beans", it was interesting to note that they do not differ very widely from the picture taken of the original material for the present cultures.

Harter in his comparison of the disease with that caused by *Phoma subcircinata* states that "The spots are smaller, more nearly round and the pycnidia are smaller and fewer in number.

The peculiarity of the organism studied here is that it was isolated from a pod that had large lesions but in the inoculation experiments it caused a leaf, stem and flower spot with only very slight spots on the pod.

The disease.

So far I am under the disadvantage of having only examined the disease critically on beans artificially inoculated under greenhouse conditions, and on leaves it is rather like the description given by Smith but it was not found that the lesions are confined to the leaves. Lesions were easily obtained on the flowers, flower-buds, stems, leaf petioles and pods. They are only slight on the pods, however, and frequently appeared only as fine flecks.

On the leaves.

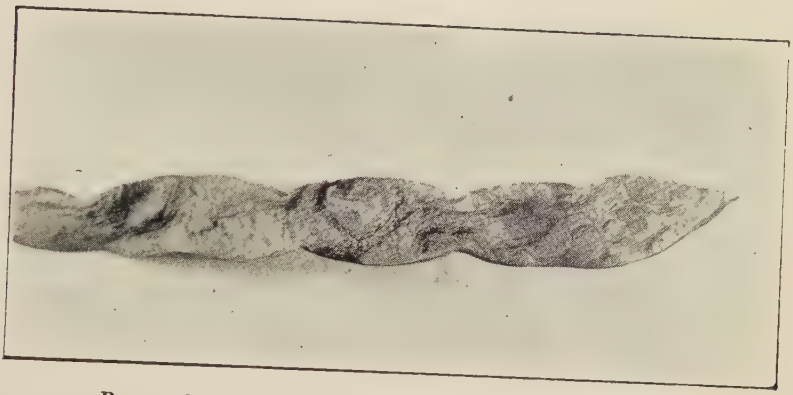
Smith's description of a light centre and a darker margin will only apply to about one-half of the spots. Many of those observed having a distin tly dark centre and then a lighter ring with a dark margin next the living tissue. The leaf spot is also marked with dark lines formed by the leaf veins being a darker brown than the other tissue.

On the flowers and flower buds.

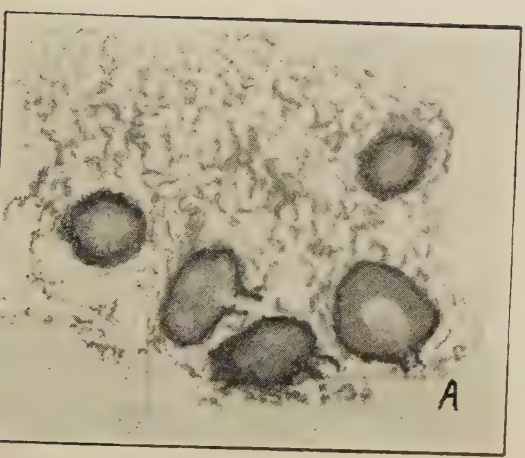
The worst feature of this disease as observed in the greenhouse was the severity with which the developing flower buds were attacked. The lesions formed on the unfolding petals and sepals and when a flower bud was once attacked it ceased normal development, turned brown and dropped off within a few days. It was observed that the parts of the flower bud were the most readily attacked.

On the stems and petioles.

The lesions were a deep reddish brown and ranged in size from 1 to 20 mm. in length. Some were observed to be much longer but as they continue developing it was considered that they resulted from the coalescing of several. The lesions were generally narrow extending lengthwise of the stem but as the plant matured they widened and in some cases extended entirely around in the case



Bean pod infected with P. PHASEOLINA. Note lesions.



o micrograph of P. PHASEOLINA Spores oozing at A

Culture of PHYLLOSTICTA PHASEOLINA showing masses of spores on surface.

of a petiole attacked and half way in the case of a stem. It was noticed that the majority of the lesions were near the nodes or where the cotyledons had dropped off. The lesions elsewhere had a slightly different shape and were often quite sharply pointed at the upper and lower extremities.

On the pods.

Here as it has already been mentioned the lesions are very small and seldom developed over 1 mm. in diameter. These lesions were very dark in color. The centre was nearly black with a reddish margin. The developing bean pods were injured apparently by the readiness with which the organism attacked the remains of the sepals around the stem and causing a lesion that frequently involves the peduncle so that the food supply appeared to be cut off. That this was so could not be definitely determined. The beans certainly did not reach a normal size but it was impossible to say how great an influence the greenhouse conditions had on the plant.

Morphology of the organism.

The spores in a fresh culture are ovoid-cylindrical, straight or very slightly curved and hyaline. Under lower power magnification, many appear as two gullulate with some having as high as three or four guttules. Ellis described *Phoma subcircinata* as being two-nucleate.

The spores ranged on potato dextrose agar from 9.3 to 3.8 to 4.6 x 1.7 microns and averaged 6.48 x 2.62. Saccardo's were 6 x 2.5 and Smith gave them as 4-6 x 2-2.5. Ellis and Everhart report *Phoma subcircinata* as being 5-6 x 2-2.5 but Harter in making a study of the type material states that he found the spores to average 7,2x2.88. Harter also finds a range in size of the spores on various media.

The spores from old cultures are very different in appearance and vary from the shortest that are reported from fresh cultures to spores that are 17 microns long. In old cultures there seem to be two types of spores, one being the same as reported for the fresh culture and the other is darker, thick-walled type, much wider and filled with guttules or oil drops. In one or two cultures these large heavy walled spores are constructed in the middle and appeared as if septate.

The spores germinate in from 12 to 24 hours in agar and sterile water, though germination is generally very poor in the latter. A very noticeable feature of the germination of the spores is the tremendous increase in size of many of the spores which apparently occurs at the same time as the germ tubes are developed. In hanging drops of agar planted with spores of the average size, germinating spores became nearly round and 17 microns long and 14 wide. This swelling was not so prominent a feature in sterile water cultures though in that medium they have been measured up to 12 microns wide. A few were measured on the plants shortly after they had germinated but these had only increased slightly. Spores that do not germinate or germinate very slowly do not appear to increase in size. One lot of spores placed in a watch glass in ste-

rile water did not germinate to any extent. These examined a week later were found to contain a number of the larger thicker-walled spore which had become septate. The spores germinate first by one germ tube which is generally followed by a second from the opposite pole. This is sometimes followed by a third from the side. Germination may be slow and the developing germ tube may look like a secondary spore for a while. The germ tube becomes septate very early and also soon branches.

The spores are borne in pycnidia that vary greatly in size, 75 to 100 microns being the size of the smaller. The pycnidia on potato dextrose and all other media that is especially favorable for growth appear as if multi-ostiolate but it is considered that this is due to a coalescing of the pycnidia which are very numerous during their formation as sections cut through a developing colony show that this is quite possible. On colonies that are on a rather unfavorable substratum the pycnidia are far apart and there is generally only one ostiolum. The larger of the pycnidia measured 175 microns in diameter. The pycnidia are very delicate as the walls are only made up of two to four layers of thick walled, slightly darker cells that form a pseudo-parenchymatous tissue. Old pycnidia may become nearly black but the immature ones are as a rule translucent. This seems to depend on the substratum for on some media they are very difficult to see; the pink mass of spores in the centre with the dark ring of cells around the ostiolum being all that could be easily seen. In all but the very black pycnidia the ostiolum showed as a ring, but on sectioning pycnidia it was seen that it really is a short neck made up of cells similar to those in the walls and 5 to 6 microns long. As the spores mature in the pycnidia they are forced out in a pink mass. In cases where the pycnidia are on the surface of the substratum they ooze over the surface and give the colony the same appearance as that of a heavily sporulating colony of *C. lindemuthianum*. Where the pycnidia are embedded in the substratum the spores are forced out in any direction and the result is that a colony that is some three weeks old has little pinkish masses of spores forced down into the medium from the bottom of the colony.

The mycelium is variable in diameter, some being 11 microns wide with cells 15 to 30 microns long. Such mycelium branches and rebranches until it is of a fine distributive nature at the edge of the colony. The cell contents are hyaline and contain large oil droplets or vacubles which are more prominent as the colony ages. The pycnidia are placed in the normal colony in an indefinite manner There is no sign of a stroma only a few strands of dark mycelium growing around each pycnidium. In a colony that grew on a very unfavorable medium, and in another on potato dextrose agar at 14° C, the pycnidia were formed in branched radiating rows towards the edge of the colony as though following some special strand of mycelium. A few hanging drops of agar were left after one of the germination tests and on being examined later it was noticed that three small pycnidia had developed.

Appearance in pure culture.

The colony starts as a few radiating stands of white mycelium and shows clearly in from two to three days after the plate has been poured. The colonies

grew at the average rate of 6.3 mm. a day for the first six days after becoming apparent to the naked eye. This organism apparently has a wide range of temperature requirements. One fairly extensive test gave the best growth at a temperature that was fluctuating between 16° and 19°. A later test with more constant temperatures gave the most rapid growth at between 20 and 21° C. These are only an indication, however, as the incubators are in constant use for culturing other organisms and the opening and closing makes it impossible to keep the temperature constant. Good growth has been obtained at temperatures ranging from 15 to 23°C. At 26°C and over the rate of growth declines very rapidly. Some growth was obtained at 12°C, scarcely any growth at 28°C, and at 33°C growth of the organism was inhibited quickly.

As the colony develops on potato dextrose agar, it takes on first a reddish shade that gradually darkens and becomes olivaceous black. The change in color appears to be almost entirely due to a change in the color of the walls of the developing pycnidia which are very abundant. On some other agars this dark color is not so evident. Similar characteristics show an oatmeal agar.

On an agar made from the stems of beans after the juice had been removed the characters were much the same but on the agar made with the juice the reddish color was the most prominent feature.

The appearance of the colony varies with the environmental conditions, a high temperature giving a black stroma-like colony and a low temperature giving a thick dark olive-colored colony. Colonies moved into the laboratory from a dark incubator proved to be sensitive to the light as the pycnidia formed in rings. This zonation was evident in a colony grown on cornmeal in the laboratory. The colonies show the spores, at the end of four or five days after culturing, as pink masses on the surface.

The colonies of this organism bear a striking resemblance to cultures of *C. lindemuthianum* that were being grown at the same time especially as to the pink masses of spores and the dark appearance of the colony. The pycnidia also bear a resemblance to the small sclerotia that are developed in the Colletotrichum cultures.

Artificial Inoculations.

These have been made at various times throughout the late winter and early spring on seedlings, plants in flower, and on plants where the pods were half formed. Inoculations were made by spraying on the spores with an atomizer or by placing a few drops of a spore suspension on the leaves. In all the experiments the conditions were the same as for inoculations with *C. lindemuthianum* some of which were also being carried on at that time (moist chamber for 48 hours at a temperature of 70F.) Smith in his inoculation experiments used a medicine dropper and left the plant under a bell jar for from 3 to 10 days. Good infection was obtained in two days though it possibly might be improved if left a little longer, especially if it means taking them out into a dry atmosphere at the end of the 48 hours. The best infection was obtained

on plants that were flowering, then those with half grown pods and lastly seedlings. The lesions were generally noticeable in from five to six days after inoculation as brown flecks that slowly developed and took on the characteristic color for the part infected. It was found impossible to distinguish between the ear y stages of this disease and anthracnose. Special attempts were made to get infection upon the full grown pods. They were placed in a spore suspension for from 48 to 70 hours and this failed. The epidermis was rubbed to remove the trichomes but without result. An attempt to get infection with spores in a dilute agar gave very confusing results as the checks also gave a browning of the epidermis like a lesion.

A brief study of the method of infection indicated that infection takes place through the more unprotected parts of the plant and in one instance what looked like infection through a stomate was observed. The tendency of the disease to develop around tender parts and around the old wounds from the dropping of the cotyledons would make it seem that it needed a break in the epidermis to establish itself readily.

The organism was reisolated repeatedly from the lesion, the affected tissue being first externally sterilized.

Summary and conclusions.

I. An organism isolated from a bean pod secured from Annapolis county, Nova Scotia, apparently infected with *C. lindemuthianum* is temporarily considered as being *Phyllosticta phaseolina* Sacc. and distinct from the conidial stage of *Diaporthe phaseolarum* (C. & E.) Sacc. commonly considered as *Phoma subcircina a* and which primarily causes a pod spot of lima beans.

II. The organism seems to agree very close'y with the descr'pt!on given by Smith of Phy losticta phaseolina but further work is necessaey actual y to dete mine by comparative cultures whether the present isolation is essentially *P. phaseolina.*

III. The organism has already been reported by Dearness from Canada as occurring on *Phaseolus parennis.*

IV. It has not been possible to determine its economic importance and the disease has been studied only from articificial inoculations on *Phaseolus vulgaris* in the greenhouse. Under such conditions it is important because of the injury to blossom.

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NOTE.—Since this paper was submitted for publication Dr L.L. Harter, to whom a culture was sent, writes as of June 15, 1925. "It resembles very closely the organism which I have isolated and studied frequent y from material collected from various parts of the United States."

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THE INSPECTION OF IMPORTED PLANT PRODUCTS AT MONTREAL

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The item "plant products" as you are aware covers a very large proportion of the goods arriving in Montreal from foreign countries, the chief of them which we inspect are nursery stock, vegetables, fruit, cut flowers, grain, lumber, coffee, unground spices, nuts, and broom corn.

In 1923, the regulations governing the inspection of plant products imported from foreign countries were revised on the recommendation of the Destructive Insect and Pest Act Advisory Board, Ottawa, and were brought into effect on September 1st, 1923. These regulations were passed in order to assist in preventing the introduction of foreign pests into our Dominion. The proverb "prevention is better than cure", is well exemplified by the foreign pests that have already entered our country and are costing thousands of dollars each year by their ravages, as well as for the spray material used in their control. Our worst insect pests today are nearly all of foreign origin. The European corn borer, which came from Austria or Hungary on consignments of broom corn I think, is undoubtedly one of our worst pests; it is steadily marching on and spreading rapidly in Ontario.

Other important pests which are worthy of special mention and which have been imported, due to our close proximity to the large agricultural country to the south are the brown-tail moth and the gipsy moth, the latter of which has already cost the United States millions of dollars in an endeavour to control, and which we hope will not get a foothold in Quebec.

It may be of interest to you to know how we enforce or carry out the Regulations at the port of Montreal, in order to prevent the introduction of further pests.

Our staff consists of four inspectors and a stenographer; we are located in the Customs building at the foot of McGill Street near the docks, which is an ideal location for our work.

I think Government regulations are similar to all big business undertakings, that is, in order to make them successful, it is essential to receive the ful est co-operation from all those whom they may concern. We have to depend very largely on the co-operation of the steamship officials, and Customs officers, in locating our consignments for inspection.

The steamship companies are very courteous and permit us to look over the ships' manifest, which is a document with an itemized list of the boat's cargo, for all points in Canada, the United States and other contries, so that we know excactly what is coming in from foreign countries *via* water.

We have a much harder task to keep track of what is coming into the country *via Rail*, as our railway systems have not yet managed to make up a manifest for each trainload of produce arriving in Canada and I do not suppose such a manifest would be of very great help, as we have a very long border line. These cars are switched at the border and we would need a very large staff if we had to place an officer at each of the border stations. The transportation companies at present have a separate manifest for each car, so that the best we can do at Montreal in regard to the rail shipments is to concentrate on produce that clears customs at Montreal. The bonded shipments for points outisde Montreal go through to destination without being intercepted by us. Nursery stock not arriving at St. John, N. B. but at other seaports along the Eastern coast of North America is bonded on Montreal or Niagara Falls for inspection and is intercepted by us.

All invoices of plant products that clear customs at Montreal, must be certified by one of our staff before the entry is passed. This is an easy matter for the customs brokers, as we are located in the customs building where they pass their entries, so that we have a record of all plant products for the port. We are entirely dependent on the customs officials to block any entries of plant products that have not been certified by one of our staff. A list of plant products has been isued to the chief checker so that they are always on the watch for such shipments.

When not busy with the inspection of nursery stock an inspector visits the railway express sheds where the fresh fruits and vegetables arrive each morning from the United States.

I believe that it is almost as important to inspect vegetables and fruits for insects, as it is plants; although the inspection of nursery stock receives special attention; and rightly so, as here we might have an insect lurking, waiting for its host plant to put forth its foliage so that it may feed upon it in the spring, and lay its eggs, and thus start an infestation.

The Regulations covering the importation of nursery stock are very strict and now that they have been in force for over a year, I think there are very few shipments from countries other than the United States which escape inspection by one of the members of the Department.

During last summer, it was found advisable to permit the importation of nursery stock through the mail from all countries other than the United States, as people were handicapped who wanted to import nursery stock in small quantities. The minimum freight and express rates on small quantities were so high, that the transportation charges were perhaps in some cases, five times the actual value of the goods. In order to cope with this matter, a new clause was inserted in the Regulations permitting the importation of nursery stock through

the mail on the condition that the importer have all his parcels ordered from countries east of Canada, addressed in care of the Plant Inspector, Montreal; and all parcels ordered from countries west of Canada addressed in care of the Plant Inspector, Vancouver. Consequently all parcel post shipments arriving in Canada must be inspected either at Vancouver or Montreal.

One of our inspectors visits the post office the first thing every morning, inspects the parcels and re-addresses them so that they proceed to final destination with as little delay as possible.

Nursery stock arriving at the port of Montreal *via* boat is nearly all inspected at the docks, unless the Department has a local inspector at the final point of destination where the consignment is billed to; in that case the goods proceed to destination for inspection.

Navigation at the port of Montreal opened for the season of 1924, at the beginning of May, and closed at the end of November. During the period, 500 calls were made by boats carrying cargo to Montreal. All these boats were liable to have some kind of plant products on board, which would be subject to inspection under the Regulations of the Destructive Insect and Pest Act.

We also met most of the passenger vessels last season and inspected any plants that passengers were carrying with them, or packed in their baggage.

We are kept very busy in the fall at Montreal, attending to importations of nursery stock. In the spring most of the nursery stock is shipped by way of St. John.

Last fall as many as 7,000 cases of nursery stock arrived in one week, but this was exceptional Most of the cases were bulbs; time did not permit our opening every box, so we opened one box under each mark, and if it was found to be in good condition, the other boxes under the same marks were "passed".

Quite a number of pests were intercepted during the past year, most of them being insects that are already present in Canada. One serious pest taken was an egg mass of the gipsy moth on a consignment of azaleas from Belgium. This case carried the Belgian certificate of inspection so that it goes to prove that no matter how careful the inspector may be in the county of origin, occasionally a pest will be missed, and this necessitates the re-examination of the plants on arrival at destination.

The following is a summary of the nursery stock which was inspected at Montreal during the past year (1924):

Fruit Trees	Small Fruits	Ornamentals	Roses	Fruit Seedling	Ornamental Seedlings	Bulbs	Greenhouse Plants	Roots
427	674	128,457	76,518	2,430	5,000	4,754,403	26,629	284,673

Total packages	8,109
Total value	$ 409,022.50

INSECTS OF THE SEASON IN SOUTHERN QUEBEC FOR THE YEAR 1924

C. E. Petch & T. Armstrong, Dominion Entomological Laboratory, Hemmingford, Que.

Cutworms.

Cutworms were not so numerous as in 1923 and the damage effected therefore was unimportant. Some individual cases of infestation were reported. A number of the growers have learned a lesson from past experiences, and they scattered poisoned bait just as soon as the first injury was noted, this method giving control in all cases without exception. The red-backed cutworm (*Euxoa ochrogaster* Gor) was the most important species around the Hemmingford District.

Cabbage Maggot. (**Hylemyia brassicae** Bouché)

The little white eggs were to be found clustered around the young plants about the third week of June, which was a week later than last year. Shortly afterwards the young cabbage plants began to wilt and die. From the number of plants at which eggs were found the infestation seemed to be serious, but, due to the lateness of the season and the good start the cabbage plants had made before the appearance of the insect, the injury was considerably reduced, Some gardens in the Hemmingford district had 50% of the plants destroyed.

Onion maggot. (**Hylemyia antiqua** Meig.)

The onion maggot was more prevalent than last year, and in some localities the loss to seedling onions was over three times that of 1923, but in other places the loss was somewhat reduced. Small tin pie plates containing a bait made by boiling ½ oz. Sodium arsenite in 1 gal. water and adding 1 pint cheap molasses, with excelsior for the flies to light on should be placed in the onion fields to control this pest. Gardeners still persist in delaying the placing of the pans until the fly has commenced to lay eggs, whereas they should be distributed when the seedlings are about 1½ inches high and before egg-laying has commenced.

Potato beetle. (**Leptinotarsa decemlineata** Say.)

As in the past this pest was present in all districts where potatoes are grown but the infestation was not very serious.

Beet leaf-miner. (**Pegomyia vicina** Lint)

The beet leaf-miner severely injured a large percentage of the leaves of beets in all districts visited. It was present more especially in the Montreal district and on one 2-acre field 80% of the leaves were infested. The eggs are laid on the underside of the leaves and the maggots bore into them and eat out

mines between the upper and lower epidermis. This injury to the leaves decreases the size of the root crop, and if grown for seed, the quantity of seed produced is often materially lessened by the partial defoliation of the plants.

Diamond-back moth. (**Plutella maculipennis** Curtis)

On August 26 a piece of late sown turnips in a Montreal market garden was completely eaten. On going through the patch but few cabbage worms and still fewer cabbage loopers were seen. However, there was a large quantity of very active larvæ nearly one half inch in length. These were identified as larvæ of the Diamond-back Moth, which occasionally become troublesome.

White grubs. (**Lachnosterna** spp.)

The injury from white grubs was light in most of the infested areas in 1924 but they did enormous damage in 1923. A big flight of June Beetles is anticipated this coming May and June and if such a flight occurs serious damage is to be expected in 1926. Thus the farmer should begin to plan his rotation so that the least susceptible crops will be grown on infested land in 1926. A repetition of last year's enormous damage may be averted by practising a proper rotation.

Raspberry cane borer. (**Oberea bimaculata** Oliv.)

The Raspberry Cane Borer was very bad in the area south of the St. Lawrence River this year. A considerable amount of the two year wood exhibited serious borer injury. There was a large number of eggs laid this year and it is predicted that where cutting out was not practiced there will be considerable damage done.

Clover head weevil. (**Tychius picirostris** Fab.)

In the Quebec Society Report for 1915-16, Dr. DuPorte reported this insect as doing considerable damage to red clover in the summer of 1915. He also stated that the insect was present in previous years but not in sufficient numbers to be of any economic importance. This year we have to report this insect as being abundant in the red clover heads at Covey Hill, Que. As many as 6 to 8 weevils were collected from a single head. The heads were dark brown in color and withered in appearance.

Plum curculio. (**Conotrachelus nenuphar** Herbst.)

This insect was not injurious in any of the fruit districts this year. Many orchards were visited but very few adults were secured.

Apple curculio. (**Tachypterelus quadrigibbus** Say.)

The apple curculio was first observed in the apple trees of June 3, increasing from this date on until July 14. The new brood of adults first appeared on

July 23. In unsprayed orchards this pest punctured as high as 50% of the fruit, but in sprayed trees the injury was very much less. With but one exception this insect was the worst pest of apple this year.

Codling Moth. (**Carpocapsa pomomella** L.)

This insect has greatly increased during the past few years and this year some unsprayed trees showed as high as 40% infestation. The injury has practically all been of the "sideworm" type.

Bud moth. (**Tmetocera ocellana** Schiff.)

This early spring insect was not troublesome to any extent. In some orchards it was more prevalent than in others, but where orchards were carefully sprayed at the correct times this insect was almost entirely absent.

Aphids.

The orchards in Quebec are surprisingly free from these small but trouble some pests, and nicotine sprays are not necessary. Aphids,however, give some trouble on nursery stock, and the trees have to be carefully watched for this pest.

Apple maggot. (**Rhagoletis pomonella** Walsh).

Probably the most serious pest of apples in the Hemmingford and Covey Hill districts is the apple maggot. July 15, usually, the flies make their appearance, but this year the first fly was observed on July 9, which constitutes a Quebec record in all probability. In orchards treated for this insect there is a great reduction in the infestation, but in untreated orchards 100% loss has been observed and reported. Ent. Circ. No. 28, of the Entomological Branch, Dept, of Agric., Ottawa, deals with this insect and its control in Quebec.

Fall webworm. (**Hyphantria cunea** Dru.)

Towards the end of June eggs of the fall webworm were laid, and shortly after this the webs of the caterpillars could be seen especially in apple trees. There was a considerable number of webs this year particularly on the unsprayed trees. The webs covered a considerable area by August 20, and the webworms mostly in the third instar, were feeding vigorously. Any orchard sprayed for apple maggot is not likely to be troubled with this pest, because the spray is applied just about the time the young webworms are hatching and before they commence to make the web.

Elm leaf miner. (**Kaliofenusa ulmi** Sunde.)

In certain district near Hemmingford this recently imported pest was observed. It was noticed doing considerable damage to elms at Covey Hill and

serious damage at Franklin Centre, Stockwell, and Mt. Johnson. The injury caused by this insect is as the name implies in the elm leaf. Mines somewhat similar to beet leaf miner work are made, and in badly infested trees practically every leaf will have a blotched appearance.

The maple borer. (**Plagionotus speciosus** Say.)

For a number of years this insect has been doing damage to the sugar maple in this and surrounding disticts. Many trees in the maple woods are dead or dying directly or indirectly from the injuries of this insect.

Caterpillars feeding on leaves of oak.

During the month of August there was an infestation of caterpillars feeding on the leaves of ask, *Quercus alba* Linn. Defoliation was quite severe, for the bare appearance could be noticed a considerable distance from the tree. The caterpillar was a species of *Anisota*, probably *senatoria*.

Maple leaf cutter. (**Paraclemensia acerifoliella** Fitch)

In the sugar maple bushes in the Hemmingford and Covey Hill districts a severe infestation of the above insect occurred this year. In one bush practically every leaf on every tree was marked with one or more of the peculiar ring-like patches. These patches were the work of the larvæ of *Paraclemensia acerifoliella*.

Slugs

Gardens in Montreal West were very materially injured by slugs which were present in very large numbers.

Potato Flea beetle (**Epitrix cucumeris** Harr.)

This insect was quite numerous on potatoes and tomatoes in several districts. This and allied flea-beetles are not taken seriously enough by the growers, because they really do very considerable injury to the young plants.

Imported cabbage worm. (**Pieris rapae** Linn.)

Present in medium numbers wherever cabbages were grown south of the St. Lawrence River.

Peacock fly or Sunflower maggot. (**Straussia longipennis** Wied.)

One large field of sunflowers near Lennoxville had 99% of the sunflowers infested with the larvæ of this fly by July 31 and reports of serious injury were received from Richmond, Milby, Huntingville and Cookshire. The value of the crop is very considerably reduced by its attacks and the growing of this crop is being discontinued by many farmers owing to the attacks of this insect.

Cigar case-bearer. (**Haplotilia fletcherella** Fernald.)

This insect is very destructive to apple foliage in the region of LaSalle and along Lake St. Louis. In the fall the twigs were almost covered in many instances with the overwintering cases.

Cranberry rootworm beetle. (**Rhabdopterus picipes** Oliv.)

By July 12, an apple orchard at Rougemont, Que. was severely injured by this insect. One half the crop on two thousand trees was severely eaten and the leaves were also considerably eaten. This is the first record of this insect doing serious injury in Canada.

Round-headed apple-tree borer. (**Saperda candida** Say.)

Continues to be injurious to apple trees in many sections of the province. Abbotsford, Rougemont, Hemmingford districts and Missisquoi county are the places most seriously affected.

Currant spanworm. (**Cymatophora ribearia** Fitch.)

A few cases of severe injury were noted at Ste. Anne's and Beauharnois on both wild and cultivated varieties.

Buffalo tree-hopper. (**Ceresa bubalus** Fabr.)

Numerous scars were found on young trees in the Hemmingford district. The importance of attacks from this insect has not been sufficiently emphasized because when the scars are numerous the functions of the bark are interfered with In consequence, the vitality of the tree is materially lessened and the tree becomes sickly and often dies.

Apple Tent caterpillar (**Malacosoma americana** Fabr.)

It was found mostly along roadsides, fences, etc. especially on wild cherry. There was an increase of 100% in Central Quebec over 1923 but it was held in check and developed very slowly up to June 20 owing to the cool, wet weather.

Marmara

Apple-tree bark-miner. (**Gracillaria elotella** Busck.)

Serpentine mines in the epidermal bark of young apple trees was noted in several orchards near Hemmingford.

Gipsy moth. (**Porthetria dispar** L.)

Several hundred egg masses were found by the Gipsy Moth Scouts in the Belle Vallée about ten miles east of Hemmingford. This is the first time this insect has been collected in any numbers in Canada.

Case-making clothes-moth.—(**Tinea pellionella** L.)

This household pest is common in many places in Quebec and has caused very serious losses in and injuries to clothing and other household goods. It is much more serious than is generaly realized.

NOTES ON PLANT DISEASES IN QUEBEC DISTRICT FOR 1924.

Omer Caron, Botanist, Dept. of Agriculture.

Cereals.

The seed disinfection campaign started a few years ago has brought about very satisfactory results. We have no complete and accurate statistics as to this but the dealers give us the information that they are selling more and more formalin for this purpose. Although we firmly believe in the efficiency of the copper carbonate treatment for oat disinfection we have not yet tried to introduce this method since it is always dangerous to invite the farmers to change their methods too often. With us the formalin dry treatment gives good results. Formalin is a cheap material and when the directions for its use are scrupulously adhered to it does not materially affect the germinative power and the strength of the seed.

Potatoes.

During the season of 1924 many complaints have been received from Eastern Quebec regarding the Black leg disease. On account of the high percentage of said disease in fields some producers have been refused certification for their tubers.

It sometimes happened that the damage attributed to Black leg was rather caused by the Sclerotium disease of potatoes. We have made cultures on potato-dextrose-agar with material kindly supplied by Mr. H. N. Racicot and we have thus obtained an organism identical with the one discovered by Mr. O. W. Lachaine in New-Brunswick a few years ago. It may then be stated that the Sclerotial disease is now established in the Province of Quebec.

Small fruits.

We must mention here a strawberry disease which seems of importance for it is generally widespread around Quebec city. It is a sort of crown-rot. Following a dry spell the leaves turn yellow, wrinkle, wilt and the plant dies within a couple of days. When pulled away it is generally observed that the rootlets are rotten and the interior of the crown is brownish. The Senator Dunlap is the most seriously affected variety. Though rather common in the United States this disease is not considered a serious pest, probably because it never causes as much damage with our neighbours as with us, where the percentage

of diseased plants ran as high as 50%. The fact that it attacks isolated plants or frequently two plants united by runners induced us at first to believe it was bacterial in origin. The exact cause of the disease still remains imperfectly known.

Last Summer we sent to our field horticultural inspectors a questionnaire which they were asked to fill out. We have also personally inspected a large number of fields and in comparing our notes with the data received from the field men a certain number of facts was noticed which may be reported here.

1) The disease attacks the strawberry plants specially after the second wintering;

2) it is particularly serious on dry sandy soils well exposed to sunshine in Summer and not covered by snow in Winter;

3) a dressing of nitrate of soda and even of manure appears to have a preventive effect;

4) the disease does not develop to any extent in weed infected stands nor in plantations, sheltered during Winter.

These observations though not absolute have been repeated in a sufficient number of cases to make us believe that they are of some significance. Until we have had an opportunity to complete our observations we are of the opinion of those who claim that this disease is a physiological one. It would therefore be a consequence of an uprooting due to the frost. It is supposed that on account of the action of the frost the roots are broken. When the next Summer drought sets in, the plant lives for a while on its own supplies but when no more water is available it dies out. In such a case, as the soil itself is deprived of water, the formation of new rootlets is made impossible. We have not quite given up the bacterial theory but many more observations would have to be made before we are in a position to prove it.

Vegetables.

Last Summer we saw at Joliette a field of cauliflowers infected by a disease which forms blackish blisters on the under side of the leaves. This caused the affected plants to rot and the damage were already considerable when we happened to visit this field towards the middle of August. With such serious infection, there was no time to be lost and we at once urged the use of a 4-4-40 Bordeaux mixture with the addition of about half a pint of molasses per three gallons of mixture and one half ounce of soap for the same quantity. According to the report received later on from the producer the result wasvery satisfactory.

Some leaves of the diseased cauliflowers placed in a moist chamber grew in a few days an organism bearing macrospores belonging to a species of **Alternaria,** probably **Alternaria** (**Macrosporium**) **brassicœ** Berk.

OOSPORE-LIKE BODIES IN CULTURES OF PHYTOPHTHORA INFESTANS

By H. R. Angell.

How the fungus causing Late Blight of Potato overwinters is a problem that has, we feel, not been altogether solved. The general infection that suddenly appears in fields in the Fall when weather conditions are favourable has not yet been satisfactorily explained and that there is some other means of overwintering than as mycelium in diseased tubers is a possibility. In the seventies Worthington G. Smith reported that he had found oospores in diseased tubers, but DeBary disproved this. Sadebeck later showed that they were those of *Pythium Equiseti*, while Massee expressed the opinion that they were Chlamydospores of a Fusarium. Smorawski in a single instance found bodies that he called immature oospores. Clinton, in 1910, reported that he had in pure cultures of Phytophthora infestans found perfect oogonia, antheridia and even oospores. Jones at Vermont, at the same time, announced that he had found in pure cultures immature bodies apparently of an oogonial nature but whose identity was doubtful.

Individual bodies showing types of structures

Large diameter mycelium developing oospore—like bodies in culture.

With the object of finding out something more about these bodies and under what conditions they are produced the present investigations were undertaken. About the middle of October 1924 the writer collected from the experimental plots of the Botany Department of Macdonald College some potato leaves infected with *Phytophara infestans*. Attempts at the isolation of the organism on ordinary laboratory media (potato, potato-dextrose, rice, cornmeal) failed owing to the rapid growth of saprophytic organisms and the unsuitability of the media for *P. infestans* At the same time, however, the precaution was taken against failure by placing bits of leaf tissue from the edges of the diseased are s on slices of potato tubers cut under sterile conditions. These in moist chambers yielded a vigorous growth of the desired fungus, and after a few transfers to fresh slices of potato it was possible to o ɔtain mycelium that was purely *Phytophtora infestans*. This was first transferred to bean agar, but the resulting growth was very slow and poor. Oatmeal agar, 50 g. oatmeal, 20 g. agar, 500 cc. water, made without straining and sterilized at 17½ lb. for 30 min. proved a most satisfactory medium. Excellent growth over the whole surface of the slant was obtained. In making transfers care was taken to use a large quantity of the inoculum, including some of the substratum. The cultures were kept in a closed cupboard in the laboratory where the temperature averaged about 18oC. Inoculations of potato plants with spore suspensions from one of these cultures resulted in typical lesions of late blight. Sliced tubers inoculated with the mycelium after it had been in culture for four months developed an excellent surface growth. After about six weeks material from the pure cultures was examined carefully under the microscope, and revealed the presence of a small number of brown oospore-like bodies. Only two or three tubes, (one especially) out of about 20 showed these structures. From the best of these, transfers were made to another series of tubes and these were kept for three weeks in a humidifier in a closed cupboard. The agar used in making these cultures was strained oat-meal (50 g. oatmeal, 20 g. agar, 1000 water). Growth on these was just as good as in the others, and at three weeks when the first examination was made the same brown oospore-like bodies were found. Practically every tube yielded them in greater or less quantity. Whereas in the first cultures they were found singly and only towards the upper and thinner portions of the slant, in these tubes they were everywhere, and not only singly, but in twos, threes, fours and more. They were borne terminally on much-branched, thick, light brown, differentiated, clumped masses of mycelium. Only in two instances were antheridia found and the oospores were apparently still immature. A few attempts at germinating these bodies have been made, but unsuccessfully. Tubes were placed outside during January and left to freeze. It was hoped that the mycelium would be killed and the brown bodies remain uninjured. From this material transfers were made to fresh oatmeal agar and to potato slices. No growth, however, resulted. Hanging drops containing three or four bodies isolated from fresh cultures also gave negative results. In another case they were dried over sulphuric acid for 48 hours,

and then placed in a hanging drop to which was added a small bit of a potato leaf. After some days some changes were observed in the protoplasmic contents. In two cases spherical hyaline bodies suggestive of zoospores were seen moving inside some of the bodies. They were carefully watched but nothing further happened. Apparently it was but streaming of the protoplasm.

Interesting results were also obtained by growing the fungus in liquid extract of oatmeal. Large pieces of inoculum and substratum from agar slopes were placed in Erlenmeyer flasks containing the liquid 1-8" deep. Care was taken not to drown the inoculum. Scant surface, but a large amount of sub-surface, growth in the medium was the result. The amount of differentiated mycelium bearing the oospore-like bodies was very marked. Time did not allow making careful search for antheridia, but later further studies will be made.

The average size of these bodies taken from various cultures, solid and liquid, varied around 33u.

Stained sections of diseased potato leaves which were allowed to rot in moist sand showed many spherical bodies about 6u in diameter. The nature of these bodies is unknown. Attempts at infection of potato tubers and leaves with the rotten material failed.

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WINTERING OVER AND INFECTION OF PUCCINIA MALVACEARUM, MONT.

H. Hill, B.S.A.

This paper consists of a brief report of germination tests and inoculations made with the teliospores of *Puccinia Malvacearum* which had overwintered outdoors in Quebec on the stems and leaves of the hollyhock.

The purpose of the work was to determine the possibility of the organism living over the winter as a teliospore and germinating the following spring, causing infection of healthy plants.

History.

The organism is a uredinaceous fungus belonging to the so-called leptoform; it has neither æcia nor uredinia, producing only teliospores. The teliospores usually germinate *in situ* as soon as mature to form promycelia with sporidia.

Work has been done on this organism by several investigators, including McAlpine, Massee, Plowright, Halsted, Daudeno, Eriksson, Taubenhaus. It is interesting to note that this is one of the organisms upon which Eriksson's mycoplasm theory is based. These workers in general agree that the fungus is carried over the winter. (1) As developing mycelium in the tender young leaves. (2) With the seed.

Plowright and Massee also suggested that the teliospores survive the winter on dead or decaying leaves. Daudeno attempted to solve this problem through actual experiments but obtained negative results. Taubenhaus conducted germination tests with teliospores which had overwintered out of doors and obtained germination on several occasions. Taubenhaus does not mention the percentage of germination obtained or the percentage of teliospores that had already germinated *in situ*; nor did he conduct inoculation experiments with healthy plants to determine if these spores were able to cause infection.

Morphology of Teliospores.

The teliospores are borne in knobs, composed of different maturity; the older spores possessing longer pedicils and extending to the outside of the knob or fascicle. The young teliospores are at first one-celled and are continually being formed even while old spores in the same sorus are in a state of germination. There is considerable variation in the form and size of the teliospores. The normal spore is two-celled, slightly constricted at the center and tapering towards both extremities. The normal spore is 53.8 microns by 15 microns with a range of 38 to 65 microns by 9 to 25 microns. One-celled mesosphores and three-celled spores may be also found. Taubenhaus reports also the occurrence of four -celled spores but they have not come under my attention. Both cells of the teliospore may germinate, sending forth promycelia; but as a rule germination is confined to the apical cell. The general type of promycelium is a long slender tube with the protoplasmic contents of the germinated cell collected at its extremity. After a short time the protoplasmic portion divides into four cells.

According to Taubenhaus the sporidia are formed in one of two ways. (1) The four cells of the promycelium may separate into free and independent cells. Each of these cells later sends out a little protrusion which elongates and swells up as the contents of the mother cell is gradually passed into it, and thus a mature sporidium is formed, which readily breaks away from the basidial cell and germinates. In the other type the four cells of the promycelium do not break apart but ea h sends out a little sterigma which gradually swells up until the sporidium is formed, into which the contents of the basidial cell is passed.

The sporidium is then abstricted and germinated. The latter form may be considered the normal type.

In my own germination tests observations of sporidia formation were practically lacking, due perhaps to the rapidity with which the process takes place.

The material which was used for my first set of germination tests and inoculations was procured on February 26 from a bed of hollyhocks situated in front of the Chemistry Building at Macdonald College. The material had been subjected to the full severity of the winter's frost. According to the college records the thermometer registered as low as—35 degrees Fah. during this period and the mean temperature for January-February was about 9 degrees F. These temperatures represent the average winter temperatures for the region so that the retained vitality of the teliospores could not be due to an unusually mild winter.

Various sori on different parts of the plants were first examined to determine, by means of the empty spores, the percentage of teliospores that had already germinated *in situ*. It was very difficult to arrive at any definite percentage as the spores in some sori were almost entirely germinated while in others as high as fifty per cent were still ungerminated. As an approximate determination I would say that about 75% of the teliospores had germinated before this date.

The ungerminated teliospores may be due to late infection in the fall, the teliospores remaining dormant in the winter and becoming mature in the spring; or due to the fact that the spores in the individual sorus mature at different times, the younger spores in some of the older sori may be immature when winter comes and may not mature until the following spring.

Teliospores were placed in water obtained from melted snow in Van Tieghem cells. Germination was noted in twenty-four hours. About twelve percent of total germination of the ungerminated spores was obtained.

Three healthy hollyhocks were inoculated by placing teliospores on the under surface of the leaf. The plants were thoroughly watered and placed under a bell-jar. On March 13 a single sorus was observed on each of the leaves infected. Permanent slides were made of sections through these sori and examined. Teliospores in different stages of maturity were noted. Material was also gathered at later dates up until the end of March. Germination tests and further inoculations were made.

Three additional plants were inoculated in a like manner, two of which became infected. On the one plant only a single sorus was produced while on the other plant a group of six sori were produced on the one leaf. It was noted that material collected during dry and warm weather would not germinate. Some of these sori were placed on the leaves of healthy plants in an endeavor to produce infection but success was not obtained due perhaps to scarcity of inoculum.

Conclusions.

The immature teliospores of *Puccinia Malvacearum* are able to withstand the severity of winter in Québec and germinate the next spring producing infection of healthy plants.

The percentage of teliospores which overwinter and the percent viable is very low so that the teliospores cannot be considered as the chief means of spring infection in Québec.

Bibliography.

Taubenhaus, J. J. A contribution to our knowledge of the morphology and life history of Puccina malvacearum Mont. —Phytopathology 1: 55-62. —Pl. XII—XIV, 1911.

ABSTRACTS OF CANADIAN PLANT PATHOLOGICAL LITERATURE.

A. W. McCallum.

The abstracts and references given herewith include the papers on plant pathology published in Canada during 1924.

Baribeau, B. Fletrissure et Pourriture de la Tige du Tournesol dans la Province de Québec. Sci. Agric. 3: 397—400. Fig. 1-6. 1923. — The symptoms of the wilt of sunflowers which has been noted in several districts in Quebec are described. Beans and turnips were also found affected. The sclerotia overwinter in the soil and remain viable for at least two years. The causal fungus is believed to be *Sclerotinia libertiana.*

Bisby, G. R. The Sclerotinia Disease of Sunflowers and other plants. Sci. Agric. 4: 381-384. Pl. 1. 1924.—In Manitoba sunflowers, and carrots and parsnips in storage are subject to severe injury by *Sclerotinia.* Alfalfa, red clover, soy bean, and sow thistle are also attacked. Sclerotia from sunflowers were germinated and the measurements of the asci and ascospores were found to agree with those of *Sclerotinia sclerotiorum.* From the fusions of hyphæ in culture from different hosts and from cross-inoculations it was concluded that but one fungus was present and that was *S. sclerotiorum.*

Brittain, W. H. Methods employed in recording results of spraying and dusting experiments in apple orchards. Sci. Agric. 4: 141—151. 1924.

Dickson, B. T. Saltation in the Organism causing "Black Dot" Disease of Potato in Canada. Trans. Roy. Soc. Can. (3rd series). 17 (Sect. 5): 123-128. Pl. 3. 1923.—In culturing the organism which causes black dot of potatoes two variants of the type form, one which produced conidia only and one which

produced both conidia and sclerotia, were encountered. In typical cultures sclerotia only are formed. The variants have been cultured throught ten generations without reversion. Several parallel cases are mentioned.

Dickson, B. T. Oat smut control experiments in 1923. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 77-79. 1924.—With a variety of hull-less oats the Cu So 4 dip was found to be the most effective of the several treatments used.

Drayton, F. L. Survey of the Prevalence of Plant diseases in the Dominion of Canada, 1923. Canada Dept. Agric. Exp. Farms Branch: 4th Ann. Rept. 1—125. 1924—Reports from every province are included. There is information concerning 333 diseases found on 102 hosts.

Eastham, J. W. Report of Provincial Plant Pathologist, Vancouver. 18th Ann. Rept. B. C. Dept. Agric. for 1923: 41-43. 1924.—Notes on root blight of seedling and heart rot of mature mangels which by some are said to be due to *Phoma betæ* and by others to unfavourable soil and weather conditions, white pine blister rust, and Colorado beetle.

Faull, T. H. Forest Pathology: In Report of Forestry Branch, 1923 Ann. Rept. Min. Lands and Forests, Ont. for 1922-1923: 197-207. 1924.—Red heart rot of balsam fir—a common and destructive decay of this species—is described and the cause attributed to *Stereum sanguinolentum*.—Six types of defective balsam fir and four of spruce are described and considered in relation to utilization as pulpwood.—The alternate stage of the fern rust (*Hyalopsora aspidiotus*) has been found to occur on three year old leaves of *Abies balsamea*

Fritz Clara W. Cultural Criteria for the Distinction of Wood-Destroying Fungi. Trans. Roy. Soc. Can. (3rd series). 17 (Sect. 5): 191—288. Pl. 1-12. 1923.—This investigation was undertaken in order to provide a laboratory method —based on cultural characteristics—to supplement the field methods—propinquity of fruit bodies and gross characteristics of decayed wood —used for the identification of wood rots. An introductory historical review of the study of wood destroying fungi, both in nature and in artificial culture, is given. Eleven of the common wood-destroying polypores and six different forms affecting balsam fir were used. In the case of the eleven fungi cultures were obtained from sporophore tissue and compared with cultures from decayed wood. For the decays of balsam fir cultures were of necessity secured from rotted wood. Later, two of these were identified on account of similarity to tissue cultures as *Poria subacida* and *Polyporus balsameus*. Cultures were grown in a non-illuminated incubator at 22oC. A number of synthetic and vegetable media were used but for diagnostic purposes potato-dextrose agar was found to be the most suitable. Most of the forms permitted a wide variation in growth conditions without a corresponding change in cultural characteristics. A key for the identification of the seventeen fungi studied is presented.

A distinct strain of *Fomes igniarius*—that obtained from poplar—was observed. Chlamydospores are reported in *Polyporus balsameus, P. borealis, P. schweinitzii,* and *P. versicolor.*

Gordon, W. L. Studies concerning injury to seed oats after smut disinfection. 16th Ann. Rept. Que. Cos. Prot. Plants for 1923-1924: 79-94. Pl. 1-4. 1924.—This work was carried on in order to determine the factors which cause injury to seed oats after treatment for smut. Three varieties of hulled and one of hull-less oats were used with several different treatments and variations of these treatments. The results obtained with each variety are described for each treatment.

Gussow, H. T. Plant diseases in relation to certification of seeds. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 72-79. 1924.—The importance of the dissemination of diseases by means of seed is emphasized and the lack of precise information concerning such diseases commented upon.

Gussow, H. T. Seed Potato Certification. 1—23. King's Printer, Ottawa 1924.—An address before the Select Standing Committee on Agriculture and Colonization outlining the origin and development of the present system of potato certification as carried on by the Dominion Department of Agriculture. Reference is made to leaf roll and mosaic, the standards for field and tuber inspection are given, and the possibility of utilizing potatoes for the manufacture of starch and alcohol discussed.

Gussow, H. T. Wheat Rust. 1-25. King's Printer, Ottawa. 1924.—The economic importance of rust is pointed out and the salient features of the problem—barberry eradication, physiological strains, breeding of resistant varieties and methods of overwintering of uredospores are reviewed. The inadequacy of the present appropriation for the proper prosecution of the problem is emphasized and increases in the staff and facilities for carrying on this work are strongly urged.

Gussow, H. T. Report of the Dominion Botanist. Can. Dept. Agric. Exp. Farms Branch for 1923-1924: 1-53. Fig. 1-7. 1924.—The annual report of the Division of Botany dealing with the various phases of investigative work which have been carried on during the year at the central and field laboratories. Among others, there are sections devoted to forest pathology, potato certification, raspberry mosaic and leaf curl, cereal rusts, smuts, and root rots, and fire blight.

Howitt, J. E. A review of our knowledge concerning immunity and resistance in plants. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 9-24. 1924.—Some of the more important achievments in the production of disease resistant plants are recounted and the significance of the terms immunity, resistance, apparent immunity, apparent resistance, and tolerance is discussed.

While the causes for the three latter conditions are not very difficult to explain the reasons for immunity and resistance are very complex. The principal causes apparently are anatomical modifications and biochemical reactions. The writer believes that the future research on this subject will lie largely in the field of biochemistry. A very extensive bibliography is appended.

Kelsall, A. Dusts and Dusting in Crop Pest Control. Sci. Agric. 5: 37-51. 1924.

Maheux, Georges. Millardet—the creator of applied phytopathology. 16th Ann. Rept. Que. Cos. Prot. Plants for 1923-1924: 57-60. 1924.—A sketch of the work of this investigator to whom belongs the credit of improving and introducing to general use the solution which later became known as Bordeaux mixture. It is noted that the action of copper sulphate on fungi had been first recorded in 1807 by Benedict Prevost. In 1914 a beautiful monument in momory of Millardet was erected by the grape growers of France in the botanical garden at Bordeaux.

McCallum, A. W. Abstracts of Canadian plant pathological literature. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 145-147. 1924.

Newton, R., and W. R. Brown. Is the Apparent Winter-Killing of Sweet Clover and Red Clover a Result of Disease injury? Sci. Agric. 5: 93-96. Fig. 1-4. 1924.—White sweet clover which was thought to have suffered winter injury was found to contain black sclerotia and the injury is probably due to *Sclerotinia* sp. In red clover the indications are that this fungus is an important contributory factor to the apparent winter injury.

Scott, G. A. Cultural characteristics of certain Colletotrichum species. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 123-137. Pl. 1-5. 1924. —Five fungi-*Vermicularia varians, Colletotrichum tabificum, C. atramentarium, C. atrovirens,* and a form isolated in Quebec—which have been found associated with black dot of potatoes were studied both from the morphological and physiological points of view. As a result the writer concludes that these organisms are identical. A sixth form—a variant of the Quebec fungus—was found to differ somewhat from the others.

Shoemaker, J. S. Lime Sulphur injury. Sci. Agric. 4: 180-184. 1924.

Stone, R. E. Preliminary investigations on the Root-Rot and Blight of Canning Peas. Sci. Agric. 4: 239-241. Fig. 1-2. 1924.—In some parts of Ontario, particularly along the north shore of Lake Ontario, growers of canning peas have suffered much loss from a disease which is apparently a root rot. Investigation showed that several organisms are associated with this trouble but that *Fusarium vasinfectum* var. *pisi* and *Pythium debaryanum* are constantly present. Inoculations with these forms produced the typical diseased

condition. Work has been commenced with the use of resistant varieties and good yields have been obtained with several of these when sown in heavily infected soil.

Stuart, William. The Relation of Science to the Potato industry. Sci. Agric. 4: 205-209. 1924.—The history of the potato industry is traced from 1848 onward and in the course of this review the role which diseases of this plant have played is described.

Vanterpool T. C. The stripe or streak disease of tomatoes in Quebec. 16th Ann. Rept. Que. Soc. Prot. Plants for 1923-1924: 116-123. Pl. 1-2. 1924. —A progress report upon a study of this obscure disease. The general symptoms are described and some preliminary inoculation work mentioned.

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